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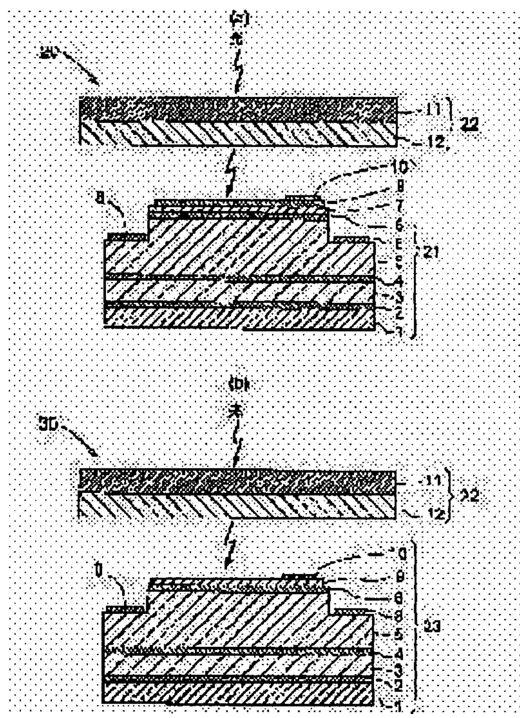
(54) FLAME SENSOR

(57)Abstract:



PROBLEM TO BE SOLVED: To provide a flame sensor whose wave sensitivity is controlled.

SOLUTION: The flame sensor 20 comprises a filter device 22 constituted by arranging a plurality of filter means 11 and 12 in series with duplication in the progression direction of incidence light, and a photoreceiver 21. In the transmissivity spectrum of synthesized light by a plurality of filter means 11 and 12, the first transmissivity in a detection objective wavelength range is larger than the second transmissivity in a shield wavelength range in longer wavelength side than the detection objective wavelength range. Also, the first sensitivity value in the specific first wavelength in the detection objective wavelength range is in the shield wavelength range and is 10,000 times or more of the value in the second sensitivity in the second wavelength which is longer by 50 nm than the first wavelength.

* NOTICES *

CLAIMS

[Claim(s)]
[Claim 1] The filter equipment which consisted of superimposing two or more filter means on a serial, and arranging them to the travelling direction of incident light, In the synthetic light transmittance spectrum are the flame sensor which comes to have light-receiving equipment which receives the light which passed said filter equipment, and according to said two or more filter means The 1st permeability in the wavelength region for detection is larger than the 2nd permeability in the protection-from-light wavelength region which is in a long wavelength side rather than said wavelength region for detection. The flame sensor whose value of the 1st sensibility in the 1st predetermined wave in said wavelength region for detection is 10,000 or more times of the value of the 2nd sensibility [in / it is in said protection-from-light wavelength region, and / from said 1st wave / with a wave / 2nd / 50nm long wavelength].
[Claim 2] The filter equipment which consisted of superimposing two or more filter means on a serial partially, and arranging them to the travelling direction of incident light, It is the flame sensor which comes to have light-receiving equipment which receives the light which passed said filter equipment. Said light-receiving equipment Substrate layer structure, By coming to have two or more light-receiving layer structures which were established on said substrate layer structure and in which each contains a euphotic zone, and being partially superimposed on said two or more filter means Two or more formation of the synthetic light transmittance spectrum of the light penetrated at said light-receiving equipment side is carried out partially. Corresponding to said two or more synthetic light transmittance spectrums, each of said light-receiving layer structure is arranged, and it sets with the 1st composition light transmittance spectrum of said two or more synthetic light transmittance spectrums. The 1st permeability in the wavelength region for detection is larger than the 2nd permeability in the protection-from-light wavelength region which is in a long wavelength side rather than said wavelength region for detection. The value of the 1st sensibility in the 1st predetermined wave in said wavelength region for detection of a flame sensor including the light-receiving layer structure arranged corresponding to said 1st composition light transmittance spectrum It is in said protection-from-light wavelength region, and they are 10,000 or more times of the value of the 2nd sensibility [in / from said 1st wave / with a wave / 2nd / 50nm long wavelength]. The 2nd composition light transmittance spectrum of said two or more synthetic light transmittance spectrums is a flame sensor formed by applying further a filter means by which the light of said wavelength region for detection is removable to the light of said 1st composition light transmittance spectrum.
[Claim 3] The flame sensor according to claim 1 or 2 whose value of said 1st sensibility is 100,000 or more times of the value of said 2nd sensibility.
[Claim 4] The flame sensor given in any of claim 1 to claim 3 they are by which one of said two or more filter means has the property that the average transmission coefficient in the wavelength range of 400nm - 700nm wavelength is 10% or less at least, and other one of said two or more filter means has the property that the average transmission coefficient in the wavelength range of 300nm - 400nm wavelength is 30% or less at least.

[Claim 5] A flame sensor given in any of claim 1 to claim 4 other at least one [whose] at least one of said two or more of the filter means is a colored glass filter, and is a multilayers filter they are.
[Claim 6] A flame sensor given in any of claim 1 to claim 5 constituted by equipping two or more semi-conductor layers with which are the semiconductor devices for which said light-receiving equipment comes to prepare substrate layer structure and the light-receiving layer structure containing a euphotic zone established on said substrate layer structure, and said substrate layer structure is equipped with two or more buffer layers which improve the crystallized state of said substrate layer structure they are.
[Claim 7] The flame sensor according to claim 6 said whose euphotic zone is the semi-conductor of a direct gap form.
[Claim 8] The flame sensor according to claim 6 or 7 whose bandgap energy of said euphotic zone is 3.6eV or more.
[Claim 9] The flame sensor according to claim 8 whose bandgap energy of said euphotic zone is 4.0eV or less.
[Claim 10] The flame sensor according to claim 8 whose bandgap energy of said euphotic zone is 4.1eV or more.
[Claim 11] The flame sensor according to claim 10 whose bandgap energy of said euphotic zone is 4.4eV or more.
[Claim 12] The flame sensor given in any of claim 6 to claim 11 they are by which said euphotic zone contains AlxGa1-xN (0<=x<=1).
[Claim 13] The flame sensor given in any of claim 6 to claim 12 they are by which an acid-resisting means to reduce the reflection factor of the incident light in said euphotic zone is formed in the incident light side on said euphotic zone in said light-receiving layer structure.
[Claim 14] The flame sensor according to claim 13 said whose acid-resisting means is a light transmission layer with a refractive index smaller than said euphotic zone.

[Translation done.]

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] This invention has wavelength selection nature and relates to the flame sensor which can receive alternatively the light (light in the wavelength region for detection) of the wavelength range of the request of the incident light.
[0002]
[Description of the Prior Art] It is also called for that it constitutes it that light (indoor light), sunlight, etc. from various lighting devices are irradiated depending on the location installed although having good sensibility to the light from a flame is called for, a flame sensor having sensibility in the wavelength range of a flame for a certain reason so that it may not have sensibility in the wavelength range of indoor light or sunlight. Moreover, current uses the semi-conductor of a direct gap form for the light sensing portion, and the semi-conductor photo detector to which absorption edge wavelength (cut-off wavelength) was adjusted by adjusting the bandgap energy of the semi-conductor is used. Here, sensibility (a unit is A/W) shows the photocurrent (A) of which occurred to the optical reinforcement (W) irradiated by the flame sensor, and it can be said that sensibility is high, so that the photocurrent to generate is large.
[0003] The semi-conductor of a direct gap form is used as a euphotic zone here because the wavelength selection nature that it changes rapidly with absorption edge wavelength (equivalent to the bandgap energy of a euphotic zone), and the absorption coefficient can dissociate alternatively and can carry out light absorption of the wavelength before and behind absorption edge wavelength is greatly seen when the wavelength property of an absorption coefficient is investigated since the light absorption process in the euphotic zone is performed by direct transition. Since the light absorption process in the euphotic zone is performed by the indirect transition on the other hand when the semi-conductor of an indirect gap form is used as a euphotic zone, the wavelength property of an absorption coefficient changes gently. Therefore, when the semi-conductor of an indirect gap form is used for a euphotic zone, wavelength selection nature is not seen greatly.
[0004] Luminescence which exists in an ultraviolet area among luminescence of a flame is conventionally made applicable to detection, and since a flame sensor which has sensibility only in luminescence of the wavelength region for detection was constituted, he intercepts the light which prepares the light filter of one sheet and is not made applicable to detection so that a euphotic zone may be covered, and was trying only for the light of the flame in the wavelength region for detection to reach a euphotic zone. The sensibility at the time of preparing a light filter so that a euphotic zone may be covered is drawn by the photocurrent (A) of which occurred to the optical reinforcement (W) irradiated by the light filter in the euphotic zone which received the light which penetrated the light filter. Therefore, by adjusting the permeability spectrum of a light filter, since the spectrum of the light irradiated by the euphotic zone is also adjusted, the wavelength sensibility of the flame sensor obtained as a result is also changeable.
[0005]

[Problem(s) to be Solved by the Invention] However, even if it constituted the flame sensor which used the semi-conductor of a direct gap form for the euphotic zone, and was equipped with the light filter, it did not come to solve the problem of having sensibility to the light from the indoor light and the sunlight from various lighting devices. Specifically in the wavelength of 300nm - 400nm and the wavelength range of 320 morenm - 400nm which are the boundary wavelength region of the light of the flame in the wavelength region for detection, and sunlight and indoor light, a problem is in that cutoff of light is inadequate, and the standup of the permeability spectrum of the colored glass filter as a light filter as shown in a list at drawing 3 being loose. Moreover, it cannot consider as 1/10,000 or less value of the value of the sensibility in the protection-from-light wavelength region which has the value of the sensibility to the flame in the wavelength region for detection in a long wavelength side rather than the wavelength region for detection about the semi-conductor layer used as a euphotic zone itself. Consequently, since protection from light by the light filter was inadequate, it turned out that there is a problem that a flame sensor generates a photocurrent to sunlight or indoor light.
[0006] As a light filter, there are some which are called the multilayers filter other than a colored glass filter, as shown in drawing 5 , the light of the specific wavelength range can be intercepted good, and it has the property that the standup is still steeper. however, the sunlight which interference hardly occurs about any light other than the specific cutoff wave length range, but spreads in the large wavelength range since a multilayers filter is a filter constituted so that light might be negated using interference of light -- almost -- especially, the light of the flame in the wavelength region for detection -- a long wave -- there is a problem of carrying out incidence of the light by the side of merit to a euphotic zone. Therefore, the wavelength selection engine performance demanded even if it uses a multilayers filter only by one sheet as a light filter was not able to be filled.
[0007] Conventionally, as a light filter, it was used with the photo detector in which a colored glass filter has the semi-conductor layer of the direct gap form which is a euphotic zone, and when the light of the same optical reinforcement was irradiated and was measured in all wavelength regions, the sensibility in a protection-from-light wavelength region was able to set the sensibility ratio even to about 1/100 to 1/10,000 value of the value of the sensibility to the light of the flame in the wavelength region for detection. In fact however, the luminous intensity (for example, optical reinforcement of the sun before and behind the wavelength of 400nm) in a protection-from-light wavelength region Compared with the optical reinforcement (for example, optical reinforcement of the flame before and behind the wavelength of 300nm) of the flame in the wavelength region for detection, it will become very large. The sensibility in the protection-from-light wavelength region obtained in the operating condition of an actual flame sensor had dropped to 1/100 - 1/1000 to the light of the flame in the wavelength region for detection of the value of sensibility.
[0008] Furthermore, in spite of having prepared the light filter of one sheet with wavelength selection nature in the incident light side of a flame sensor, it was found out that that a flame sensor has sensibility also to sunlight or indoor light according to the standup of a light transmittance spectrum being loose has some which are depended on the following reasons.
[0009] It takes into consideration that any light other than the wavelength region for detection is not completely removed even if it uses a light filter conventionally. That the light which was not able to be removed with a light filter is absorbed by the euphotic zone at the same time it prepares a light filter in order to prevent The bandgap energy of a wrap semi-conductor layer tended to be adjusted for the euphotic zone and the euphotic zone to predetermined cut-off wavelength, those semi-conductor layer itself tended to be made to act as a light filter, and it was going to remove the light of long wavelength from the wavelength region for detection completely. However, defective level etc. existed in those semi-conductor layers, and the photocurrent was generated by the light (the wavelength region for detection a long wave merit's light) of the energy with which bandgap energy is not filled in the defective level being absorbed. Consequently, it had sensibility also to the light of long wave length rather than predetermined cut-off wavelength, and the problem that perfect wavelength selection nature could not be attained had arisen.
[0010] when produce the PIN photodiode as a photo detector with a GaN system ingredient , since p-

$Al_xGa_{1-x}N$ ($x > 0.2$) which constitute p layers prepared in the incident light side from a euphotic zone (i layers) have bad crystal quality , specifically , many above defective level contain -- have -- further -- it be 3 element mixed crystal and the problem that the presentation ratio in a semi-conductor layer cannot become uniform easily arise . Therefore, even if it adjusted the bandgap energy of p layers and i layers and prepared cut-off wavelength near 280nm - 330nm, the problem of having the sensibility of extent which serves as a noise from the cut-off wavelength to the light of a between with a wavelength of about 400nm had arisen.

[0011] Thus, by the flame sensor constituted by having the conventional light filter, it has not been recognized that the sensibility resulting from the defective level in a semi-conductor layer poses a problem, and the measures were not taken, either. Therefore, the flame sensor which can detect only the light of the flame in the wavelength region for detection with sufficient sensibility was not producible.

[0012] This invention is made in view of the above-mentioned trouble, and the purpose is in the point of offering the flame sensor by which wavelength sensibility was adjusted.

[0013]

[Means for Solving the Problem] The first description configuration of the flame sensor concerning this invention for solving the above-mentioned technical problem The filter equipment which consisted of superimposing two or more filter means [like] of the column of a claim according to claim 1 on a serial, and arranging them to the travelling direction of incident light, In the synthetic light transmittance spectrum are the flame sensor which comes to have light-receiving equipment which receives the light which passed said filter equipment, and according to said two or more filter means The 1st permeability in the wavelength region for detection is larger than the 2nd permeability in the protection-from-light wavelength region which is in a long wavelength side rather than said wavelength region for detection. The value of the 1st sensibility in the 1st predetermined wave in said wavelength region for detection is in said protection-from-light wavelength region, and is in the point which is 10,000 or more times of the value of the 2nd sensibility in with a wave [2nd] 50nm long wavelength from said 1st wave.

[0014] The second description configuration of the flame sensor concerning this invention for solving the above-mentioned technical problem The filter equipment which consisted of superimposing partially two or more filter means [like] of the column of a claim according to claim 2 on a serial, and arranging them to the travelling direction of incident light, It is the flame sensor which comes to have light-receiving equipment which receives the light which passed said filter equipment. Said light-receiving equipment Substrate layer structure, By coming to have two or more light-receiving layer structures which were established on said substrate layer structure and in which each contains a euphotic zone, and being partially superimposed on said two or more filter means Two or more formation of the synthetic light transmittance spectrum of the light penetrated at said light-receiving equipment side is carried out partially. Corresponding to said two or more synthetic light transmittance spectrums, each of said light-receiving layer structure is arranged, and it sets with the 1st composition light transmittance spectrum of said two or more synthetic light transmittance spectrums. The 1st permeability in the wavelength region for detection is larger than the 2nd permeability in the protection-from-light wavelength region which is in a long wavelength side rather than said wavelength region for detection. The value of the 1st sensibility in the 1st predetermined wave in said wavelength region for detection of a flame sensor including the light-receiving layer structure arranged corresponding to said 1st composition light transmittance spectrum It is in said protection-from-light wavelength region, and they are 10,000 or more times of the value of the 2nd sensibility [in / from said 1st wave / with a wave / 2nd / 50nm long wavelength]. The 2nd composition light transmittance spectrum of said two or more synthetic light transmittance spectrums is in the point formed by applying further a filter means by which the light of said wavelength region for detection is removable to the light of said 1st composition light transmittance spectrum.

[0015] In addition to the like, above-mentioned first, or second description configuration, the third description configuration of the flame sensor concerning this invention for solving the above-mentioned technical problem has the value of said 1st sensibility in the point of the column of a claim according to claim 3 which is 100,000 or more times of the value of said 2nd sensibility.

[0016] The fourth description configuration of the flame sensor concerning this invention for solving the above-mentioned technical problem It adds to which third description configuration from the above-mentioned first like a publication at claim 4 of the column of a claim. One of said two or more filter means has the property that the average transmission coefficient in the wavelength range of 400nm - 700nm wavelength is 10% or less at least. It is in the point that other one of said two or more filter means has the property that the average transmission coefficient in the wavelength range of 300nm - 400nm wavelength is 30% or less at least. Here, an average transmission coefficient is the arithmetic average of the permeability in the predetermined wavelength range.
[0017] In addition to which [like and the above-mentioned first to / fourth] description configuration, at least one of said two or more of the filter means is a colored glass filter, and the point of the column of a claim according to claim 5 that other at least one is a multilayers filter has the fifth description configuration of the flame sensor concerning this invention for solving the above-mentioned technical problem.
[0018] The sixth description configuration of the flame sensor concerning this invention for solving the above-mentioned technical problem It adds to which fifth description configuration from the above-mentioned first like a publication at claim 6 of the column of a claim. Said light-receiving equipment Substrate layer structure, It is the semiconductor device which comes to have the light-receiving layer structure containing a euphotic zone established on said substrate layer structure, and two or more semi-conductor layers with which said substrate layer structure is equipped are in the point constituted by having two or more buffer layers which improve the crystallized state of said substrate layer structure.
[0019] In addition to like and the description configuration of the above sixth, the point of the column of a claim according to claim 7 that said euphotic zone is the semi-conductor of a direct gap form has the seventh description configuration of the flame sensor concerning this invention for solving the above-mentioned technical problem.
[0020] In addition to like, the above sixth, or the seventh description configuration, the point of the column of a claim according to claim 8 that the bandgap energy of said euphotic zone is 3.6eV or more has the eighth description configuration of the flame sensor concerning this invention for solving the above-mentioned technical problem.
[0021] The point of the column of a claim according to claim 9 that like, the description configuration of the above eighth, in addition the bandgap energy of said euphotic zone are 4.0eV or less has the ninth description configuration of the flame sensor concerning this invention for solving the above-mentioned technical problem.
[0022] In addition to like and the description configuration of the above eighth, the point of the column of a claim according to claim 10 that the bandgap energy of said euphotic zone is 4.1eV or more has the tenth description configuration of the flame sensor concerning this invention for solving the above-mentioned technical problem.
[0023] In addition to like and the description configuration of the above tenth, the point of the column of a claim according to claim 11 that the bandgap energy of said euphotic zone is 4.4eV or more has the eleventh description configuration of the flame sensor concerning this invention for solving the above-mentioned technical problem.
[0024] The point of the column of a claim according to claim 12 that said euphotic zone contains AlxGa1-xN (0<=x<=1) from like and the above sixth in addition to the eleventh description configuration has the twelfth description configuration of the flame sensor concerning this invention for solving the above-mentioned technical problem.
[0025] The point of the column of a claim according to claim 13 that the like and acid-resisting means which reduces the reflection factor of the incident light in said euphotic zone in said light-receiving layer structure in addition to the above sixth to twelfth description configuration is formed in the incident light side on said euphotic zone has the thirteenth description configuration of the flame sensor concerning this invention for solving the above-mentioned technical problem.
[0026] In addition to like and the description configuration of the above thirteenth, the 14th description configuration of the flame sensor concerning this invention for solving the above-mentioned technical

problem has said acid-resisting means in the point of the column of a claim according to claim 14 which is a light transmission layer with a refractive index smaller than said euphotic zone.
[0027] Effectiveness is explained below at an operation list. In the synthetic light transmittance spectrum [according to the first description configuration of the flame sensor concerning this invention] by two or more filter means Since the 1st permeability in the wavelength region for detection is larger than the 2nd permeability in the protection-from-light wavelength region which is in a long wavelength side rather than the wavelength region for detection, the wavelength of the light by which passes a filter means and incidence is carried out to the light-receiving equipment of a flame sensor is chosen restrictively. It can avoid including light other than the wavelength region for detection. Since it is ensured that it is only that to which the light received by the light-receiving equipment of a flame sensor makes a flame the origin, the possibility of incorrect detection of a flame sensor can be eliminated. Moreover, in two or more filter means formed in a flame sensor, since the property of the light transmittance spectrum which each filter means has can be set up variously, the setting degree of freedom of the synthetic light transmittance spectrum obtained as a result can make it high.
[0028] Furthermore, since the value of the 1st sensibility in the 1st predetermined wave in the wavelength region for detection is in a protection-from-light wavelength region and can make it 10,000 or more times of the value of the 2nd sensibility in with a wave [2nd] 50nm long wavelength from the 1st wave, only the light of the flame made applicable to detection is detectable with high wavelength selection nature. Furthermore, it is contained in each semi-conductor layer, and since it can prevent that originate in existence of the defective level which absorbs light other than the wavelength region for detection, and a photocurrent occurs, even if the light of the flame in the wavelength region for detection is feeble, it is detectable good.
[0029] In the synthetic light transmittance spectrum [according to the second description configuration of the flame sensor concerning this invention] by two or more filter means Since the 1st permeability in the wavelength region for detection is larger than the 2nd permeability in the protection-from-light wavelength region which is in a long wavelength side rather than the wavelength region for detection, the wavelength of the light by which passes a filter means and incidence is carried out to the light-receiving equipment of a flame sensor is chosen restrictively. It can avoid including light other than the wavelength region for detection. Since it is ensured that it is only that to which the light received by the light-receiving equipment of a flame sensor makes a flame the origin, the possibility of incorrect detection of a flame sensor can be eliminated. Moreover, in two or more filter means formed in a flame sensor, since the property of the light transmittance spectrum which each filter means has can be set up variously, the setting degree of freedom of the synthetic light transmittance spectrum obtained as a result can make it high.
[0030] Furthermore, since the value of the 1st sensibility in the 1st predetermined wave in the wavelength region for detection is in a protection-from-light wavelength region and can make it 10,000 or more times of the value of the 2nd sensibility in with a wave [2nd] 50nm long wavelength from the 1st wave, only the light of the flame made applicable to detection is detectable with high wavelength selection nature. Furthermore, it is contained in each semi-conductor layer, and since it can prevent that originate in existence of the defective level which absorbs light other than the wavelength region for detection, and a photocurrent occurs, even if the light of the flame in the wavelength region for detection is feeble, it is detectable good.
[0031] furthermore, to the light-receiving layer structure (it is hereafter described as the 1st euphotic zone) established corresponding to the above-mentioned 1st composition light transmittance spectrum To the light-receiving layer structure (it is hereafter described as the 2nd euphotic zone) in which incidence of the light of the wavelength region for detection and the light which has leaked in a protection-from-light wavelength region was carried out, and it was prepared corresponding to the above-mentioned 2nd composition light transmittance spectrum Since incidence of the light which has leaked in a protection-from-light wavelength region is carried out, the photocurrent generated by originating only in the light of the flame in the wavelength region for detection by subtracting the photocurrent generated in the 2nd euphotic zone from the photocurrent generated in the 1st euphotic

zone can be derived. Furthermore, although the current component resulting from the thermionic emission generated corresponding to a temperature change is contained in the photocurrent generated in the 1st euphotic zone and the 2nd euphotic zone, as mentioned above, the current component which originates in thermionic emission by taking the difference of a photocurrent is offset, and the effectiveness that temperature compensation can be performed is also demonstrated. Therefore, the judgment precision of turning on and off of a flame is high, and can constitute easily the flame sensor in which a highly precise temperature compensation is possible.
[0032] Even when the light of the flame which is in the wavelength region for detection which receives light from the value of the 1st sensibility of the above being 100,000 or more times of the value of the 2nd sensibility of the above is feeble according to the third description configuration of the flame sensor concerning this invention, the flame sensor which can distinguish still more clearly the photocurrent generated by the light from the photocurrent by the light which is not made applicable to detection, and can detect it can obtain.
[0033] The filter means which can intercept the light of a visible region good from an ultraviolet area according to the fourth description configuration of the flame sensor concerning this invention, Since the filter equipment which had the filter means which can intercept an ultraviolet area good especially put together is used, the light by which incidence is carried out to light-receiving equipment The light of the flame in the wavelength region for detection can be made to penetrate good, intercepting the light and ultraviolet radiation which are contained in indoor light and sunlight from various lighting devices good. Since the light of the sensibility wavelength region (wavelength of 300nm - 400nm) by the defective level which is contained in each semi-conductor layer and absorbs light other than the wavelength region for detection especially can be intercepted good, a flame sensor which a photocurrent generates only to the light of the flame in the wavelength region for detection can be obtained.
[0034] Since both the colored glass filter and the multilayers filter are applied to the light irradiated by the flame sensor according to the fifth description configuration of the flame sensor concerning this invention, the permeability spectrum near [which starts gently (or it falls)] absorption edge wavelength of the light which could be made to penetrate only the light of the specific wavelength range by the colored glass filter, and penetrated the colored glass filter with the multilayers filter can be changed steeply. That is, after penetrating two or more filter means, in other words, the permeability spectrum of the light by which incidence is carried out to light-receiving equipment can constitute the light filter which changes rapidly and which has high wavelength selection nature from specific wavelength.
[0035] According to the sixth description configuration of the flame sensor concerning this invention, the substrate layer structure of light-receiving layer structure can also make good the crystallized state of the light-receiving layer structure deposited on it by coming to have the two or more layers buffer layer which improves the own crystallized state of substrate layer structure. I hear that that the crystallized state of light-receiving layer structure is good has the low defect density which forms defective level into a layer, there is, and it seems not to have sensibility in different wavelength range from the wavelength range of a flame. The sensibility in near the absorption edge wavelength of a euphotic zone changes steeply, that is, specifically, can offer the high flame sensor of the wavelength selection nature that the wavelength range which receives light can be limited.
[0036] According to the seventh description configuration of the flame sensor concerning this invention, a euphotic zone absorbs light by direct transition because a euphotic zone is the semi-conductor of a direct gap form. Since a light absorption process is based on the direct transition in a euphotic zone, the wavelength property of an absorption coefficient changes rapidly in absorption edge wavelength (equivalent to bandgap energy), and the light of the wavelength region absorbed bordering on absorption edge wavelength and the light of the wavelength region which is not absorbed are separated clearly. Consequently, the effectiveness that high wavelength selection nature is demonstrated also in a euphotic zone can be acquired.
[0037] According to the eighth description configuration of the flame sensor concerning this invention, the flame sensor which can detect alternatively the light of the wavelength below the wavelength of about 344nm (3.6eV), i.e., the light of a flame which appears in a wavelength region with a wavelength

of about 344nm or less, by the above-mentioned euphotic zone because the bandgap energy of the above-mentioned euphotic zone is 3.6eV or more can be obtained.
[0038] According to the ninth description configuration of the flame sensor concerning this invention, the bandgap energy of the above-mentioned euphotic zone because it is [3.6eV or more] 4.0eV or less The light of the wavelength of the range of about 310nm (4.0eV) - 344nm (3.6eV) wavelength, That is, the flame sensor which can detect the luminescence peak resulting from luminescence of OH radical observed when burning the compound which contains a hydrocarbon also especially in the light of the flame in the wavelength region for detection good can be obtained. Since a light called the indoor light and the sunlight from various lighting devices which are observed by coincidence does not exist especially when the installations of a flame sensor are closed space, such as the interior of an engine, and installed in the outdoors, only the light of the flame in the wavelength region for detection is detectable good.
[0039] According to the tenth description configuration of the flame sensor concerning this invention, the flame sensor which can detect the light of the wavelength below the wavelength of about 300nm (4.1eV), i.e., the light of the flame in the wavelength region for detection, by the above-mentioned euphotic zone because the bandgap energy of the above-mentioned euphotic zone is 4.1eV or more can be obtained. Furthermore, since the above-mentioned euphotic zone does not have sensibility to the indoor light from the light, i.e., the various lighting devices etc., of the wavelength exceeding the wavelength of about 300nm etc., the flame sensor which has sensibility alternatively to the light of the flame in the wavelength region for detection can be obtained.
[0040] According to the eleventh description configuration of the flame sensor concerning this invention, the flame sensor which can detect the light of the wavelength below the wavelength of about 280nm (4.4eV), i.e., the light of the flame in the wavelength region for detection, by the above-mentioned euphotic zone because the bandgap energy of the above-mentioned euphotic zone is 4.4eV or more can be obtained. Furthermore, since the above-mentioned euphotic zone does not have sensibility to the indoor light and the sunlight (natural light) from the light, i.e., the various lighting devices etc., of the wavelength exceeding the wavelength of about 280nm etc., the flame sensor which has sensibility alternatively to the light of the flame in the wavelength region for detection can be obtained.
[0041] According to the twelfth description configuration of the flame sensor concerning this invention, a euphotic zone can set the bandgap energy of a euphotic zone as arbitration by adjusting the presentation ratio x of aluminum by consisting of an included nitride semi-conductor containing AlxGa1-xN (0<=x<=1). Consequently, although the cut-off wavelength of a euphotic zone is set up and it has sensibility neither in various lighting devices nor sunlight, a flame sensor which has sensibility to the light of the flame in the wavelength region for detection can be offered.
[0042] According to the thirteenth description configuration of the flame sensor concerning this invention, the quantity of light (the amount of energy) by which incidence is carried out to a euphotic zone compared with the case where the acid-resisting means is not established, by the acid-resisting means being formed in the incident light side on a euphotic zone can be increased. Consequently, since it is equivalent to the photoelectric conversion efficiency in a euphotic zone having increased, even if the luminous intensity from a flame is weak, it can detect with sufficient sensibility or a flame sensor can be offered.
[0043] According to the 14th description configuration of the flame sensor concerning this invention, with an acid-resisting means consisting of light transmission layers which have a refractive index smaller than the refractive index of a euphotic zone, the light transmission layer which has a desired refractive index can be produced easily, consequently incidence of the light can be carried out good to a euphotic zone by adjusting chemical composition, thickness, etc. of the light transmission layer.
[0044]
[Embodiment of the Invention] Below, the example of a configuration of a flame sensor is explained with reference to drawing 1 . The flame sensors 20 and 30 shown in drawing 1 (a) and drawing 1 (b) receive the incident light from a flame, are equipped with the ****** equipments 21 and 23 made to generate a photocurrent and the filter equipment 22 which can make the light of the wavelength range of

desired penetrate or intercept, and are constituted. The equipment which has responsibility in light-receiving equipment to the light of the flame in the wavelength region for detection is used, and the following operation gestalten illustrate and explain the light-receiving equipment 21 which consists of semiconductor device structure of an PIN mold, and the light-receiving equipment 23 which consists of semiconductor device structure of a schottky diode mold.

[0045] First, the flame sensor 20 shown in drawing 1 (a) is equipped with the light-receiving equipment 21 (PIN mold) which receives the incident light from a flame, and the filter equipment 22 which can make the light of the wavelength range of desired penetrate or intercept, and is constituted. Light-receiving equipment 21 on the substrate 1 constituted using sapphire The 1st buffer layer 2 (AlN made to deposit at low temperature), The crystal improvement layer 3 (GaN) and the 2nd buffer layer 4 (AlN made to deposit at low temperature) on the substrate layer structure produced by carrying out sequential deposition The n-type-semiconductor layer 5 (n-AlxGa1-xN (x= 0.4)), The i-type semiconductor layer 6 (i-AlxGa1-xN (x= 0.4)) of undoping, The sequential deposition of the p type semiconductor layer 7 (p-GaN) is carried out, and light-receiving layer structure is formed. It is prepared so that an electrode 8 (Ti/aluminum/Au) may serve as ohmic contact at the part on the n-type-semiconductor layer 5, and the electrode 10 (Au) is further prepared and constituted with the electrode 9 (nickel/Au) by the part on the p type semiconductor layer 7 at the part on an electrode 9. Moreover, filter equipment 22 comes to have the 1st filter means 11 and the 2nd filter means 12. Moreover, the silicon (Si) other than sapphire can also be used as an ingredient of a substrate 1.

[0046] Next, the flame sensor 30 shown in drawing 1 (b) is equipped with the light-receiving equipment 23 (schottky diode mold) which receives the incident light from a flame, and the filter equipment 22 which can make the light of the wavelength range of desired penetrate or intercept, and is constituted. Light-receiving equipment 23 on the substrate 1 constituted using sapphire The 1st buffer layer 2 (AlN made to deposit at low temperature), The crystal improvement layer 3 (GaN) and the 2nd buffer layer 4 (AlN made to deposit at low temperature) on the substrate layer structure produced by carrying out sequential deposition The n-type-semiconductor layer 5 (n-AlxGa1-xN (x= 0.4)), The sequential deposition of the i-type semiconductor layer 6 (i-AlxGa1-xN (x= 0.4)) of undoping is carried out, and light-receiving layer structure is formed. It is prepared so that an electrode 8 (Ti/aluminum/Au) may serve as ohmic contact at the part on the n-type-semiconductor layer 5. It is prepared so that an electrode 9 (nickel/Au) may serve as Schottky contact to the i-type semiconductor layer 6 on the i-type semiconductor layer 6, and the electrode 10 (Au) is further prepared and constituted by the part on an electrode 9. Moreover, filter equipment 22 comes to have the 1st filter means 11 and the 2nd filter means 12 like drawing 1 (a). Moreover; the silicon (Si) other than sapphire can also be used as an ingredient of a substrate 1.

[0047] Here, the i-type semiconductor layer 6 absorbs light by direct transition by the i-type semiconductor layer 6 used as a euphotic zone being produced with the III-V group nitride semi-conductor of a direct gap form. Therefore, by the above-mentioned flame sensor, since a light absorption process is based on the direct transition in the i-type semiconductor layer 6, the wavelength property of an absorption coefficient changes rapidly in absorption edge wavelength (equivalent to the bandgap energy of the i-type semiconductor layer 6), and the light of the wavelength region absorbed bordering on absorption edge wavelength and the light of the wavelength region which is not absorbed are separated clearly. Consequently, the effectiveness that the high wavelength selection engine performance is demonstrated by the i-type semiconductor layer 6 can be acquired.

[0048] Furthermore, in order to give wavelength selection nature to a flame sensor, adjusting the presentation ratio of aluminum in the i-type semiconductor layer 6 (AlxGa1-xN) which is a euphotic zone, and setting the bandgap energy as a desired value is performed. For example, what is necessary is just to carry out to the aluminum presentation ratio x= 0.05 or more than it to produce the flame sensor which can receive alternatively the light of the flame in the wavelength region for detection which spreads in a wavelength region with a wavelength of about 344nm or less so that the bandgap energy of the i-type semiconductor layer 6 may be set to 3.6eV or more. Or what is necessary is just to carry out to the aluminum presentation ratio x= 0.25 or more than it to produce a flame sensor which is contained in

wavelength region about 300nm or more and which receives the light of the flame in the wavelength region for detection, without receiving the light (indoor light) from various lighting devices so that the bandgap energy of the i-type semiconductor layer 6 may be set to 4.1eV or more. moreover -- or the bandgap energy of the i-type semiconductor layer 6 is set to 4.4eV or more to produce a flame sensor which is contained in wavelength region about 280nm or more and which receives only the light of the flame in the wavelength region for detection, without receiving the light from sunlight -- as -- the aluminum presentation ratio x= 0.37 or more than it -- then, it is good.

[0049] Furthermore, since the indoor light or the sunlight which were mentioned above do not exist when a flame sensor is installed in closing space, such as the interior of an engine, it is not necessary to set up large bandgap energy which eliminates them. The sake, Also especially in the light of the flame in the wavelength region for detection, a hydrocarbon The light (light of a with a 310nm or more wavelength [344nm or less] flame) of the luminescence peak (: with a wavelength of about 310nm (310nm**10nm) 4.0eV) resulting from luminescence of OH radical observed when burning the included compound (fuel which burns with an engine) by that of receiving light alternatively What is necessary is just to make the aluminum presentation ratio x or less [0.05 or more] into 0.23 so that the bandgap energy of the i-type semiconductor layer 6 may be set to 3.6eV or more 4.0eV or less when the flame sensor to cut is produced.

[0050] Here, when growing up the above-mentioned i-type semiconductor layer 6 (III-V group nitride semi-conductor), the number of the nitrogen (N) holes in a nitride semi-conductor layer can be decreased by adjusting so that the ratio (V/III) of the amount of supply of V group element to the amount of supply of an III group element may become 5000 or more. Since a nitrogen hole can serve as a hopping site which contributes to hopping conduction, it can adjust the carrier concentration in the obtained i-type semiconductor layer 6 even to low level called three or less [about 1x1015cm -] because the number of nitrogen holes decreases, and can obtain the semiconductor device which has good quantum efficiency and a good speed of response. Here, if the oxygen which acts as a carrier dopant is fully removed from the membrane formation system, carrier concentration can be adjusted even to still lower level called three or less [about 5x1014cm -]. In addition, although carrier concentration can be adjusted even to equivalent level when membranes are formed by making the value of V/III or more into 1000, or also when membranes are formed by making the value of V/III or more into 500 When the number of nitrogen (N) holes is not fully able to be decreased by forming membranes by making the value of V/III small, a problem may occur in the use as a flame sensor by which it is required that a feeble light should be detected. For example, the photocurrent which should be detected may not appear clearly from that the dark current increases by existence of the above-mentioned hopping site, the trap of the optical carrier generated by absorbing the light of the flame in the wavelength region for detection being carried out in impurity level, etc.

[0051] Drawing 2 is a graph which shows each spectrum of the light of the flame by which incidence is carried out to the flame sensors 20 and 30, sunlight, and indoor light. It is here, and in indoor light, in the wavelength range of a visible region, breadth and sunlight spread in the wavelength range of a visible region from an ultraviolet area with a wavelength of about 290nm or more, and the light of breadth and a flame has spread from the ultraviolet area with a wavelength of about 320nm or more in the wavelength range of about 200nm - about 340nm. Therefore, it is necessary to intercept alternatively the light of the wavelength range which spreads in a visible region from the ultraviolet area of indoor light which was illustrated, and sunlight, and to use for the light-receiving equipments 21 and 23 of the flame sensors 20 and 30 the filter equipment 22 which ensures that incidence only of the light of the flame in the wavelength region for detection is carried out. Furthermore, since defective level which generates a photocurrent to the light of the wavelength range of 300nm - 400nm wavelength is contain in the semi-conductor layer which constitutes a flame sensor as mention above, the light of the above-mentioned wavelength range is not irradiate by light-receiving equipment by intercept the light of the wavelength range further, but it is necessary to use the filter equipment 22 it is make not to make make it almost generate a photocurrent. Therefore, it is desirable that filter equipment 22 is equipped with at least two filter means 11 and 12 of a 1st filter means 11 to have the property that the average

transmission coefficient in the wavelength range of 400nm - 700nm wavelength is 10% or less at least, and a filter means 12 by which it has the property that the average transmission coefficient in the wavelength range of 300nm - 400nm wavelength is 30% or less at least.

[0052] With reference to the following drawing 3 - drawing 6 , the example of the 1st filter means 11 with which filter equipment 22 is equipped, and the 2nd filter means 12 is explained using the graph of each permeability property.

[0053] What is shown in drawing 3 is the permeability property of the light filter (colored glass filter) currently sold from Hoya Corp., and shows as an example U-330, U-340, U-350, and the permeability property of the light filter U-360 [light filter] is written. Here, the figure appended to each light filter expresses the wavelength from which permeability becomes the highest. By making light penetrate using the light filter which has wavelength selection nature which is illustrated, the optical reinforcement of the light of the specific wavelength range is reduced suitably. For example, if its attention is paid to the permeability property of U-330, the transparency threshold wavelength by the side of the short wavelength of a transparency peak is located in about 210nm, and since the transparency threshold wavelength by the side of merit is located in about 425nm, the optical reinforcement of light other than the with a - of with a wavelength of 210nm long wave range will be reduced. Furthermore, in the wavelength of 280nm, permeability is over 30%, permeability is over 70% in the range of the wavelength of 270nm - 370nm wavelength, and since permeability is over 80% in the range of the wavelength of 280nm - 300nm wavelength, the light of the wavelength range of the light of a flame (200nm - 340nm) can penetrate a light filter, without almost reducing the reinforcement.

[0054] however, from the standup of a permeability spectrum being loose and the skirt of a permeability spectrum dragging on So that the sunlight or indoor light near the wavelength of 400nm cannot be completely intercepted when U-330 is used, but only the light of the flame which has a euphotic zone in the wavelength region for detection may be received In a euphotic zone, even if it adjusts the bandgap energy, when defective level which receives the light of the range of 300nm - 400nm wavelength exists, sunlight and indoor light will be absorbed and a photocurrent will be generated.

[0055] What is necessary is just to perform making the impurity contained increase or increasing thickness, in order to lower the permeability of light using a colored glass filter. However, by this approach, since glass with low permeability is used, the permeability of only the light of the specific wavelength range cannot be lowered, but decline in permeability is caused in the overall wavelength range. Therefore, when making applicable to detection luminescence which exists in an ultraviolet area among luminescence of a flame, the ratio of the permeability in the wavelength for detection and the permeability in the protection-from-light wavelength region which is in a long wavelength side rather than the wavelength region for detection is about double figures.

[0056] What is shown in drawing 4 is the permeability property of another light filter (colored glass filter) currently sold from Hoya Corp., and shows as an example UV-28, UV-30, UV-32, UV-34, and the permeability property of the light filter UV-36 [light filter] are written. Here, the figure appended to each light filter is equivalent to 1/10 of the figures of transparency threshold wavelength, and if it is UV-28, it shows that transparency threshold wavelength is 280nm. Here, UV-28 are produced using phosphate glass etc. and UV-30, UV-32, UV-34, and UV-36 are produced using silicate glass etc. Unlike the filter shown in drawing 3 , this colored glass filter intercepts the light by the side of short wavelength rather than permeability threshold wavelength, and has the simple property of making the light by the side of long wavelength penetrating.

[0057] being shown in drawing 5 and drawing 6 -- Asahi -- a spectrum -- it is the permeability property of the light filter (multilayers filter) currently sold from incorporated company, and the permeability property of the light filter it writes UV300 (drawing 5) and UV325 [light filter] (drawing 6) is shown as an example. A multilayers filter is a filter constituted as high wavelength selection nature was shown by making incident light produce interference by carrying out the laminating of the glass of two or more sheets, and negating the light of the specific wavelength range by the interference. The interference fringe which shows that interference of light is used for the graph of a permeability property has appeared, and permeability can be made very small in the specific wavelength range as effectiveness of

the interference.
[0058] It turns out that a permeability spectrum changes very steeply and high wavelength selection nature is shown so that clearly out of drawing 5 and drawing 6 . For example, in UV300, the permeability of the wavelength range of 325nm - 370nm wavelength is about 0, in UV325, the permeability of the wavelength range of 340nm - 390nm wavelength is about 0, and the standup is very steeper still. What is necessary is just to adjust the thickness of the glass which carries out a laminating, in order to adjust the wavelength range of the light negated by interference.
[0059] A multilayers filter is constituted in piles two or more sheets in an ingredient with high permeability also in ultraviolet areas, such as magnesium flux, SiO2, and an alumina. The principle is constituting the ingredient of predetermined thickness in piles, interference of light arises among them and the light of specific wavelength is negated. Therefore, what is necessary is just to negate light repeatedly by producing interference for many ingredients repeatedly in piles, in order to lower the permeability of the light of the specific wavelength range. In this case, since the ingredient with the above high permeability is used, the permeability of the light of the wavelength range which interference does not produce is maintained while it has been high, consequently it can be set up until the ratio of the permeability in the wavelength for detection and the permeability in the protection-from-light wavelength region which is in a long wavelength side rather than the wavelength region for detection becomes about 5 figures.
[0060] From the above thing, U-330 which is a colored glass filter is used for the 1st filter means 11. When UV300 which is a multilayers filter is used for the 2nd filter means 12, In the 1st filter means 11, the light of the wavelength range of the wavelength of about 400nm or less of the incident light and wavelength about 700nm or more is intercepted. With the 2nd filter means 12 From the ability to shade nearly completely, the light of the wavelength range of the wavelength of 320nm - 380nm wavelength It uses combining the 1st filter means 11 and the 2nd filter means 12, and the effectiveness that light with a wavelength of 300nm or less is effectively shaded by setting the bandgap energy of a euphotic zone (i-type semiconductor layer 6) as predetermined cut-off wavelength is demonstrated. The example of the effectiveness is explained with reference to the following drawing 7 and drawing 8 .
[0061] When (A) filter means is not formed in the light-receiving side of the photodiode used as instead of [of a flame sensor] and only the (B) 1st filter means 11 (U-330) is formed in drawing 7 , the wavelength sensibility (A/W) at the time of forming the 1st filter means 11 (U-330) of (C) and the 2nd filter means 12 (UV300) in a list is shown. Although the ratio of sensibility is seen bordering on the cut-off wavelength (wavelength corresponding to bandgap energy) by (A) having adjusted the bandgap energy of the semi-conductor layer of a direct gap form used as a euphotic zone when the filter means is not established Only 50nm is triple figure (1/1000) extent between the 2nd sensibility in the wavelength by the side of long wavelength from the 1st sensibility [in / in the sensibility ratio / the above-mentioned cut-off wavelength], and the above-mentioned cut-off wavelength. Sensibility to the light of the flame which is in the wavelength region for detection by shading alternatively light other than the wavelength region for (B) detection when only the 1st filter means 11 is established as usual (in a detail) It can respond to the sensibility in cut-off wavelength, and light other than the wavelength region for detection, and a ratio with the sensibility in the wavelength by the side of long wavelength can be raised from the above-mentioned cut-off wavelength only by 50nm even to triple [about] figures (1/1000) - 4 figures (1/10,000). In fact however, the optical reinforcement (for example, optical reinforcement of the sun before and behind the wavelength of 400nm) of the wavelength range corresponding to light other than the wavelength region for detection Since it will become very large compared with the optical reinforcement of the light of the flame in the wavelength region for detection, it was difficult to distinguish and detect the photocurrent in which the photocurrent generated by receiving light other than the wavelength region for detection was also generated by becoming large and receiving the light of a feeble flame.
[0062] When the 1st filter means 11 and the 2nd filter means 12 are established, next, (C), The value of the sensibility in the light (before or after the wavelength of about 270nm corresponding to the cut-off wavelength of a euphotic zone) of the flame in the wavelength region for detection About 4 or more

(10,000 or more times) figures of the value of the sensibility in the wavelength (cut-off wavelength of a euphotic zone only 50nm a long wave before or after the wavelength of about 320nm by the side of merit) corresponding to light other than the wavelength region for detection can be raised. Furthermore, the value of the sensibility in the light (before or after the wavelength of about 270nm) of the flame in the wavelength region for detection can be preferably raised to about 5 or more (100,000 or more times) figures of the value of the sensibility in the wavelength range (wavelength order of about 320nm or, wavelength range beyond it) corresponding to light other than the wavelength region for detection. Consequently, the photocurrent generated by receiving light other than the wavelength region for detection could be made very small, and it became possible to distinguish and detect the photocurrent generated by receiving the light of a feeble flame.

[0063] Furthermore, drawing 8 is the graph which showed the case where the photocurrent value with which it integrated in all the wavelength range in [which was shown in drawing 7] three (A-C) was not being irradiated with the case where the light of a flame is irradiated. Here, although the light of a flame was made to turn on only a fixed period under existence of indoor light and the photodiode was irradiated, when the light of a flame is irradiated, it turns out that a photocurrent is generated and the light of a flame can be detected irrespective of the existence of a filter means. When only indoor light is irradiated by the flame sensor on the other hand when the light of a flame is not being irradiated namely, since it has sensibility to indoor light, the photocurrent is generated in the case (A: a broken line shows) where it does not have the filter means. Similarly, in the case (B: an one-point broken line shows) where it has only the 1st filter means 11, though it is weak, it turns out that it has sensibility to indoor light. Therefore, in above-mentioned A and B, it can be said that the wavelength selection nature as a flame sensor is inadequate.

[0064] Although it was specifically going to receive alternatively only the light of the flame which is in the wavelength region for detection using a filter means with the light-receiving equipment (here, the photodiode was used for convenience) of the conventional type shown in (B) of drawing 7 and drawing 8 so that it might understand out of drawing It was not able to be said that sensibility was producing very low light-receiving equipment to the light (here indoor light) of the wavelength range of wavelength 320nm or more.

[0065] On the other hand, in the case (C: a continuous line shows) where it has the 1st filter means (U-330) 11 and the 2nd filter means (UV300) 12, the photocurrent by which the period which is not making the flame turn on is observed is zero, and it turns out that indoor light can be intercepted good. Therefore, it turns out that a very highly precise flame sensor can be constituted from the ability of the photocurrent generated with the defective level contained in each semi-conductor layer which constitutes a flame sensor to be made very small.

[0066] With the operation gestalt beyond <another operation gestalt <1>>, although only one light-receiving layer structure was prepared in one flame sensor, the following another operation gestalten explain the case where two or more (here two) same light-receiving layer structures are prepared in one flame sensor.

[0067] The flame sensor 40 shown in drawing 9 is equipped with the light-receiving equipment 24 which receives the incident light from a flame, and the filter equipment 25 which can make the light of the wavelength range of desired penetrate or intercept, and is constituted. Although the following operation gestalten illustrate and explain the light-receiving equipment 25 which consists of semiconductor device structure of a schottky diode mold, semiconductor device structures, such as a semiconductor device of other PIN molds, may be used.

[0068] Although the 1st filter means 11 and the 2nd filter means 12 were superimposed and arranged to the serial to incident light as filter equipment with the above-mentioned operation gestalt at the incident light side of light-receiving equipment In addition to the 1st filter means 11 and the 2nd filter means 12, to incident light, the 3rd filter means was partially superimposed on the serial, and is arranged with the following another operation gestalten to the incident light side of light-receiving equipment. Consequently, the area as for which the light which passed only the 1st filter means 11 and the 2nd filter means 12 carries out incidence to light-receiving equipment 24, and the area the light in which the 3rd

filter means 13 was passed in addition to the 1st filter means 11 and the 2nd filter means 12 carries out [an area] incidence to light-receiving equipment 24 are formed.
[0069] As shown in drawing 9 , light-receiving equipment 24 on the substrate 1 constituted using sapphire The 1st buffer layer 2 (AlN made to deposit at low temperature), The crystal improvement layer 3 (GaN) and the 2nd buffer layer 4 (AlN made to deposit at low temperature) on the substrate layer structure produced by carrying out sequential deposition The n-type-semiconductor layer 5 (n-AlxGa1-xN (x= 0.4)), The sequential deposition of the i-type semiconductor layers 6A and 6B (i-AlxGa1-xN (x= 0.4)) of undoping is carried out, and light-receiving layer structure is formed. It is prepared so that an electrode 8 (Ti/aluminum/Au) may serve as ohmic contact at the part on the n-type-semiconductor layer 5. To the part on i-type semiconductor layer 6A and 6B Electrodes 9A and 9B (nickel/Au), Furthermore, Electrodes 10A and 10B (Au) are prepared and constituted by the part on electrode 9A and 9B.
[0070] By establishing two or more light-receiving layer structures, and passing only the 1st filter means 11 and the 2nd filter means 12 so that it may illustrate When the light by which the synthetic permeability spectrum was set to Y passes the 3rd filter means 13 in addition to the light-receiving layer structure (B is added to a reference number) which carries out incidence, and the 1st filter means 11 and the 2nd filter means 12 There is light-receiving layer structure (A is added to a reference number) the light by which the synthetic permeability spectrum was set to X carries out [layer structure] incidence. Moreover, the silicon (Si) other than sapphire can also be used as an ingredient of a substrate 1.
[0071] U-330 shown in drawing 3 as the 1st filter means 11 was used like the above-mentioned operation gestalt, and UV325 shown in drawing 5 as the 2nd filter means 12 was used. Moreover, UV-28 shown in drawing 4 as the 3rd filter means 13 were used. The synthetic light transmittance spectrum X is formed by applying the 3rd filter means 13 to the light of the synthetic light transmittance spectrum Y. Since the 3rd filter means 13 (UV-28) can intercept light with a wavelength [containing the light of a flame / of 280nm] - a wavelength of 290nm or less, it can be said to be that light other than the wavelength region for detection is contained in the synthetic light transmittance spectrum X, and the light of the flame in the wavelength region for detection and light other than the wavelength region for detection are contained in a synthetic light transmittance spectrum.
[0072] As mentioned above, incidence of the light of the flame in the wavelength region for detection and the light other than the wavelength region for detection is carried out to the light-receiving layer structure established corresponding to the above-mentioned synthetic light transmittance spectrum X. By subtracting the photocurrent IB generated in euphotic zone 6B from the photocurrent IA generated in euphotic zone 6A, since incidence of the light other than the wavelength region for detection is carried out to the light-receiving layer structure established corresponding to the synthetic light transmittance spectrum Y The photocurrent I (flame) generated by originating only in the light of the flame in the wavelength region for detection can also be derived. However, since it will be intercepted about 10% by the 3rd filter means 13 (UV-28) not only about light with a wavelength [containing the light of a flame] of 280nm - 290nm or less but about light other than the wavelength region for detection, As the value which amended by applying a predetermined multiplier to Photocurrent IB is shown in following several 1 by subtracting from Photocurrent IA, the photocurrent I by the light of the flame in the wavelength region for detection for which it asks (flame) can be derived. It is f= 1.1 when 10% of light other than the wavelength region for detection is intercepted by the 3rd filter means 13 in following several 1, as the multiplier f was mentioned above.
[0073]
[Equation 1] I(flame) =IA-IBxf [0074] Furthermore, although the current component resulting from the thermionic emission generated corresponding to a temperature change is contained in the photocurrent generated in euphotic zone 6A and euphotic zone 6B, as mentioned above, the current component which originates in thermionic emission by taking the difference of a photocurrent is offset, and the effectiveness that temperature compensation can be performed is also demonstrated. Therefore, the judgment precision of turning on and off of a flame is high, and can constitute easily the flame sensor in which a highly precise temperature compensation is possible.
[0075] <2> Although it performed taking out alternatively the light of the flame which is in the

wavelength region for detection using the filter equipment constituted by having two or more filter means as mentioned above, and carrying out incidence to a light-receiving equipment side With reference to drawing 10 , it explains making light-receiving equipment equipped with the acid-resisting function in which light may be reflected on the front face of the i-type semiconductor layer 6 which is a euphotic zone which constitutes light-receiving equipment, and it is prevented.
[0076] Drawing 10 (a) is the block diagram of light-receiving equipment equipped with the acid-resisting function, drawing 10 (b) is the explanatory view of the acid-resisting functional division shown in drawing 10 (a), and drawing 10 (c) is the explanatory view of the example of a comparison when not having the acid-resisting function.
[0077] First, the flame sensor 50 shown in drawing 10 (a) is equipped with the light-receiving equipment 26 (schottky diode mold) which receives the incident light from a flame, and filter equipment 22, and is constituted. Light-receiving equipment 26 on the substrate 1 constituted using sapphire The 1st buffer layer 2 (AlN made to deposit at low temperature), The crystal improvement layer 3 (GaN) and the 2nd buffer layer 4 (AlN made to deposit at low temperature) on the substrate layer structure produced by carrying out sequential deposition The n-type-semiconductor layer 5 (n-AlxGa1-xN (x= 0.4)), The sequential deposition of the i-type semiconductor layer 6 (i-AlxGa1-xN (x= 0.4)) of undoping is carried out, and light-receiving layer structure is formed. It is prepared so that an electrode 8 (Ti/aluminum/Au) may serve as ohmic contact at the part on the n-type-semiconductor layer 5, similarly, on the i-type semiconductor layer 6, it is prepared so that an electrode 9 (nickel/Au) may serve as ohmic contact, and the electrode 10 (Au) is further prepared and constituted by the part on an electrode 9. And the light transmission layer 14 is formed in the part in which the electrode 10 on an electrode 9 is not formed. Here, the light of the flame in the irradiated wavelength region for detection in which it is formed very thinly penetrates an electrode 9, and incidence of the electrode 9 is carried out to the i-type semiconductor layer 6 which is a euphotic zone good. Moreover, filter equipment 22 comes to have the 1st filter means 11 and the 2nd filter means 12 like drawing 1 (a). Moreover, the silicon (Si) other than sapphire can also be used as an ingredient of a substrate 1.
[0078] The light transmission layer 11 used here is AlxGa1-xN (0<=x<=1), and a refractive index can be adjusted by changing an atomic presentation. Magnesium flux (MgF2), calcium fluoride (CaF2), a silicon dioxide (SiO2), etc. can be used for others. In addition, when AlxGa1-xN is used, there is an advantage that it is producible in the same membrane formation process as each semi-conductor layer.
[0079] Drawing 10 (b) is drawing explaining the acid-resisting functional division with which the semi-conductor structure in the light-receiving equipment 26 shown in drawing 10 (a) was equipped. All over drawing, the refractive index of n1 (n1> n0) and the i-type semiconductor layer 6 is set [the refractive index in air] to n2 (n2> n1) for the refractive index of n0 and the light transmission layer 14. In addition, since the electrode 9 is formed very thinly, it is not taken into consideration here. Furthermore, reflection in case the acid-resisting function is not equipped is explained to drawing 10 (c) as an example of a comparison.
[0080] First, as shown in drawing 10 (a) and drawing 10 (b), a euphotic zone 6 and the light transmission layer 14 are formed, and the reflection factors R1 and R2 to the incident light which carries out incidence at right angles to a euphotic zone 6 about two examples, the case where the above-mentioned light transmission layer 14 is exposed into air, and when the light transmission layer 14 was not formed but the euphotic zone 6 is exposed into air, are shown in following several 1 and several 2. In addition, n0, n1, and n2 are the refractive indexes in air, a light transmission layer, and a euphotic zone, respectively. Here, the thickness d14 of the light transmission layer 14 is set as value:d14=lambda (incident light)/4n1 which broke the quarter wavelength of incident light by the own refractive index. In addition, the wavelength of incident light is the wavelength of light to make it penetrate, for example, is 260nm - 280nm in wavelength.
[0081]
[Equation 2]
R1=(n0 and n2-n1)2/(n0 and n2+n1)2[0082]
[Equation 3] R2=(n0-n2)2/(n0+n2)2[0083] Here, when the presentation ratio y of aluminum and Ga is

1.00, i.e., AlN, in 0.35, each refractive index is set to n0=1.0, n0=2.22, and n0=2.7. [in / in the presentation ratio x of aluminum and Ga in a euphotic zone / the light transmission layer 14] Furthermore, the thickness of the light transmission layer 14 carries out to the value which did the division of the quarter wavelength of incident light with the refractive index of the light transmission layer 14, i.e., 0.4nm. In addition, the refractive index of a euphotic zone 6 and the light transmission layer 14 is a rough value. The reflection factor R1 at the time of forming the light transmission layer 14 and the reflection factor R2 at the time of not preparing become R1=8.5% and R2=21.1% from the above thing, respectively. Therefore, when the light transmission layer 14 was formed, the light energy which contributes to a photoconduction operation compared with the case where it does not prepare will increase about 16%, and was able to make the photoelectric conversion efficiency of the flame sensor 50 increase about 16% effectually.

[0084] Since the lattice constant of a substrate differs from the lattice constant of a semi-conductor layer when making a semi-conductor layer deposit on <3> substrates, turbulence and a lattice defect may occur [the crystallized state of a semi-conductor layer]. In order to also worsen the crystallized state of the semi-conductor layer deposited further up, even if other semi-conductor layers are prepared between the substrate and the euphotic zone, turbulence will arise in the crystallized state of a euphotic zone, and the turbulence of this crystallized state will form the level which contributes to the light absorption of the wavelength region which is not desirable into a euphotic zone. In view of such a trouble, light-receiving layer structure was formed on the substrate layer structure containing a double buffer with the above-mentioned operation gestalt.

[0085] In the above operation gestalt, although the substrate layer structure of light-receiving equipment contains two or more buffer layers prepared in order to improve the crystallized state, the effectiveness is explained with reference to drawing 11 . Although the graph which shows the wavelength dependency of the light-receiving sensibility of the semiconductor device by which light-receiving layer structure was formed on substrate layer structure is shown in drawing 11 , when the continuous line shown by (a) in drawing is equipped with two or more buffer layers which were explained in the above-mentioned operation gestalt (double buffer), the broken line of (b) and (c) is as a result of [at the time of having one buffer layer as an example of a comparison (single buffer)] measurement. It is a result when the measurement result of (a) forms the light-receiving layer structure of an PIN mold (an electrode/p-GaN/i-AlGaN/n-AlGaN) on the substrate layer structure of a double buffer at a detail. The measurement result of (b) is a result at the time of forming the light-receiving layer structure of a shot key mold (an electrode/n-AlGaN) on the substrate layer structure of a single buffer. The measurement result of (c) is a result at the time of forming the light-receiving layer structure of a shot key mold (an electrode/n-AlGaN) on the substrate layer structure of a single buffer.

[0086] Although the light-receiving sensibility of (a) shows a steep change near absorption edge wavelength when substrate layer structure is equipped with two or more buffer layers and constituted, it can be said that this is the effectiveness (defective level was made not to be contained) which the crystallized state of the upper semi-conductor layer was able to become good by preparing two or more buffer layers, consequently was able to make the crystallized state of a euphotic zone good. On the other hand, light-receiving sensibility when substrate layer structure is equipped with one buffer layer and constituted ((b) and (c)) Near absorption edge wavelength shows a loose change. This Since the improvement of the crystallized state in substrate layer structure is inadequate, it can be said that it is the effect by the defective level which becomes inadequate [an improvement of the crystallized state of a euphotic zone], consequently contributes to a euphotic zone at the absorption of light of the wavelength region which is not desirable having occurred.

[0087] As mentioned above, with the above-mentioned operation gestalt, since the euphotic zone was formed above the substrate layer structure equipped with two or more buffer layers, light-receiving sensibility was able to obtain the light-receiving equipment which changes rapidly before and behind absorption edge wavelength. Consequently, the flame (wavelength region which receives light can be limited and light of feeble flame can be detected alternatively) sensor which can enlarge further the sensibility difference in absorption-edge-wavelength order was able to be obtained as mentioned above

by applying two or more filter means to light-receiving equipment. When a euphotic zone is formed above the substrate layer structure constituted by having one buffer layer on the other hand, even if it applies a filter means, the sensitivity curve in absorption-edge-wavelength order cannot become loose with as, and the wavelength region which receives light cannot fully be limited, but it becomes difficult to detect only the light of a feeble flame alternatively.
[0088] <4> Although the component of an PIN mold and a schottky diode mold was mentioned as the example and the above-mentioned operation gestalt explained it as light-receiving equipment, the invention in this application is not limited to the structure of light-receiving equipment (semiconductor device), and can be applied to an avalanche photodiode and various light-receiving equipments which used other various semiconductor devices.

[Translation done.]

TECHNICAL FIELD

[Field of the Invention] This invention has wavelength selection nature and relates to the flame sensor which can receive alternatively the light (light in the wavelength region for detection) of the wavelength range of the request of the incident light.

[Translation done.]

* NOTICES *

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1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

PRIOR ART

[Description of the Prior Art] It is also called for that it constitutes it that light (indoor light), sunlight, etc. from various lighting devices are irradiated depending on the location installed although having good sensibility to the light from a flame is called for, a flame sensor having sensibility in the wavelength range of a flame for a certain reason so that it may not have sensibility in the wavelength range of indoor light or sunlight. Moreover, current uses the semi-conductor of a direct gap form for the light sensing portion, and the semi-conductor photo detector to which absorption edge wavelength (cut-off wavelength) was adjusted by adjusting the bandgap energy of the semi-conductor is used. Here, sensibility (a unit is A/W) shows the photocurrent (A) of which occurred to the optical reinforcement (W) irradiated by the flame sensor, and it can be said that sensibility is high, so that the photocurrent to generate is large.
[0003] The semi-conductor of a direct gap form is used as a euphotic zone here because the wavelength selection nature that it changes rapidly with absorption edge wavelength (equivalent to the bandgap energy of a euphotic zone), and the absorption coefficient can dissociate alternatively and can carry out light absorption of the wavelength before and behind absorption edge wavelength is greatly seen when the wavelength property of an absorption coefficient is investigated since the light absorption process in the euphotic zone is performed by direct transition. Since the light absorption process in the euphotic zone is performed by the indirect transition on the other hand when the semi-conductor of an indirect gap form is used as a euphotic zone, the wavelength property of an absorption coefficient changes gently. Therefore, when the semi-conductor of an indirect gap form is used for a euphotic zone, wavelength selection nature is not seen greatly.
[0004] Luminescence which exists in an ultraviolet area among luminescence of a flame is conventionally made applicable to detection, and since a flame sensor which has sensibility only in luminescence of the wavelength region for detection was constituted, he intercepts the light which prepares the light filter of one sheet and is not made applicable to detection so that a euphotic zone may be covered, and was trying only for the light of the flame in the wavelength region for detection to reach a euphotic zone. The sensibility at the time of preparing a light filter so that a euphotic zone may be covered is drawn by the photocurrent (A) of which occurred to the optical reinforcement (W) irradiated by the light filter in the euphotic zone which received the light which penetrated the light filter. Therefore, by adjusting the permeability spectrum of a light filter, since the spectrum of the light irradiated by the euphotic zone is also adjusted, the wavelength sensibility of the flame sensor obtained as a result is also changeable.

[Translation done.]

TECHNICAL PROBLEM

[Problem(s) to be Solved by the Invention] However, even if it constituted the flame sensor which used the semi-conductor of a direct gap form for the euphotic zone, and was equipped with the light filter, it did not come to solve the problem of having sensibility to the light from the indoor light and the sunlight from various lighting devices. Specifically in the wavelength of 300nm - 400nm and the wavelength range of 320 morenm - 400nm which are the boundary wavelength region of the light of the flame in the wavelength region for detection, and sunlight and indoor light, a problem is in that cutoff of light is inadequate, and the standup of the permeability spectrum of the colored glass filter as a light filter as shown in a list at drawing 3 being loose. Moreover, it cannot consider as 1/10,000 or less value of the value of the sensibility in the protection-from-light wavelength region which has the value of the sensibility to the flame in the wavelength region for detection in a long wavelength side rather than the wavelength region for detection about the semi-conductor layer used as a euphotic zone itself. Consequently, since protection from light by the light filter was inadequate, it turned out that there is a problem that a flame sensor generates a photocurrent to sunlight or indoor light.
[0006] As a light filter, there are some which are called the multilayers filter other than a colored glass filter, as shown in drawing 5 , the light of the specific wavelength range can be intercepted good, and it has the property that the standup is still steeper. however, the sunlight which interference hardly occurs about any light other than the specific cutoff wave length range, but spreads in the large wavelength range since a multilayers filter is a filter constituted so that light might be negated using interference of light -- almost -- especially, the light of the flame in the wavelength region for detection -- a long wave -- there is a problem of carrying out incidence of the light by the side of merit to a euphotic zone. Therefore, the wavelength selection engine performance demanded even if it uses a multilayers filter only by one sheet as a light filter was not able to be filled.
[0007] Conventionally, as a light filter, it was used with the photo detector in which a colored glass filter has the semi-conductor layer of the direct gap form which is a euphotic zone, and when the light of the same optical reinforcement was irradiated and was measured in all wavelength regions, the sensibility in a protection-from-light wavelength region was able to set the sensibility ratio even to about 1/100 to 1/10,000 value of the value of the sensibility to the light of the flame in the wavelength region for detection. In fact however, the luminous intensity (for example, optical reinforcement of the sun before and behind the wavelength of 400nm) in a protection-from-light wavelength region Compared with the optical reinforcement (for example, optical reinforcement of the flame before and behind the wavelength of 300nm) of the flame in the wavelength region for detection, it will become very large. The sensibility in the protection-from-light wavelength region obtained in the operating condition of an actual flame sensor had dropped to 1/100 - 1/1000 to the light of the flame in the wavelength region for detection of the value of sensibility.
[0008] Furthermore, in spite of having prepared the light filter of one sheet with wavelength selection nature in the incident light side of a flame sensor, it was found out that that a flame sensor has sensibility also to sunlight or indoor light according to the standup of a light transmittance spectrum being loose has some which are depended on the following reasons.

[0009] It takes into consideration that any light other than the wavelength region for detection is not completely removed even if it uses a light filter conventionally. That the light which was not able to be removed with a light filter is absorbed by the euphotic zone at the same time it prepares a light filter in order to prevent The bandgap energy of a wrap semi-conductor layer tended to be adjusted for the euphotic zone and the euphotic zone to predetermined cut-off wavelength, those semi-conductor layer itself tended to be made to act as a light filter, and it was going to remove the light of long wavelength from the wavelength region for detection completely. However, defective level etc. existed in those semi-conductor layers, and the photocurrent was generated by the light (the wavelength region for detection a long wave merit's light) of the energy with which bandgap energy is not filled in the defective level being absorbed. Consequently, it had sensibility also to the light of long wave length rather than predetermined cut-off wavelength, and the problem that perfect wavelength selection nature could not be attained had arisen.

[0010] when produce the PIN photodiode as a photo detector with a GaN system ingredient , since p-AlxGa1-xN (x> 0.2) which constitute p layers prepared in the incident light side from a euphotic zone (i layers) have bad crystal quality , specifically , many above defective level contain -- have -- further -- it be 3 element mixed crystal and the problem that the presentation ratio in a semi-conductor layer cannot become uniform easily arise . Therefore, even if it adjusted the bandgap energy of p layers and i layers and prepared cut-off wavelength near 280nm - 330nm, the problem of having the sensibility of extent which serves as a noise from the cut-off wavelength to the light of a between with a wavelength of about 400nm had arisen.

[0011] Thus, by the flame sensor constituted by having the conventional light filter, it has not been recognized that the sensibility resulting from the defective level in a semi-conductor layer poses a problem, and the measures were not taken, either. Therefore, the flame sensor which can detect only the light of the flame in the wavelength region for detection with sufficient sensibility was not producible.

[0012] This invention is made in view of the above-mentioned trouble, and the purpose is in the point of offering the flame sensor by which wavelength sensibility was adjusted.

[Translation done.]

MEANS

[Means for Solving the Problem] The first description configuration of the flame sensor concerning this invention for solving the above-mentioned technical problem The filter equipment which consisted of superimposing two or more filter means [like] of the column of a claim according to claim 1 on a serial, and arranging them to the travelling direction of incident light, In the synthetic light transmittance spectrum are the flame sensor which comes to have light-receiving equipment which receives the light which passed said filter equipment, and according to said two or more filter means The 1st permeability in the wavelength region for detection is larger than the 2nd permeability in the protection-from-light wavelength region which is in a long wavelength side rather than said wavelength region for detection. The value of the 1st sensibility in the 1st predetermined wave in said wavelength region for detection is in said protection-from-light wavelength region, and is in the point which is 10,000 or more times of the value of the 2nd sensibility in with a wave [2nd] 50nm long wavelength from said 1st wave.
[0014] The second description configuration of the flame sensor concerning this invention for solving the above-mentioned technical problem The filter equipment which consisted of superimposing partially two or more filter means [like] of the column of a claim according to claim 2 on a serial, and arranging them to the travelling direction of incident light, It is the flame sensor which comes to have light-receiving equipment which receives the light which passed said filter equipment. Said light-receiving equipment Substrate layer structure, By coming to have two or more light-receiving layer structures which were established on said substrate layer structure and in which each contains a euphotic zone, and being partially superimposed on said two or more filter means Two or more formation of the synthetic light transmittance spectrum of the light penetrated at said light-receiving equipment side is carried out partially. Corresponding to said two or more synthetic light transmittance spectrums, each of said light-receiving layer structure is arranged, and it sets with the 1st composition light transmittance spectrum of said two or more synthetic light transmittance spectrums. The 1st permeability in the wavelength region for detection is larger than the 2nd permeability in the protection-from-light wavelength region which is in a long wavelength side rather than said wavelength region for detection. The value of the 1st sensibility in the 1st predetermined wave in said wavelength region for detection of a flame sensor including the light-receiving layer structure arranged corresponding to said 1st composition light transmittance spectrum It is in said protection-from-light wavelength region, and they are 10,000 or more times of the value of the 2nd sensibility [in / from said 1st wave / with a wave / 2nd / 50nm long wavelength]. The 2nd composition light transmittance spectrum of said two or more synthetic light transmittance spectrums is in the point formed by applying further a filter means by which the light of said wavelength region for detection is removable to the light of said 1st composition light transmittance spectrum.
[0015] In addition to the like, above-mentioned first, or second description configuration, the third description configuration of the flame sensor concerning this invention for solving the above-mentioned technical problem has the value of said 1st sensibility in the point of the column of a claim according to claim 3 which is 100,000 or more times of the value of said 2nd sensibility.
[0016] The fourth description configuration of the flame sensor concerning this invention for solving the

above-mentioned technical problem It adds to which third description configuration from the above-mentioned first like a publication at claim 4 of the column of a claim. One of said two or more filter means has the property that the average transmission coefficient in the wavelength range of 400nm - 700nm wavelength is 10% or less at least. It is in the point that other one of said two or more filter means has the property that the average transmission coefficient in the wavelength range of 300nm - 400nm wavelength is 30% or less at least. Here, an average transmission coefficient is the arithmetic average of the permeability in the predetermined wavelength range.

[0017] In addition to which [like and the above-mentioned first to / fourth] description configuration, at least one of said two or more of the filter means is a colored glass filter, and the point of the column of a claim according to claim 5 that other at least one is a multilayers filter has the fifth description configuration of the flame sensor concerning this invention for solving the above-mentioned technical problem.

[0018] The sixth description configuration of the flame sensor concerning this invention for solving the above-mentioned technical problem It adds to which fifth description configuration from the above-mentioned first like a publication at claim 6 of the column of a claim. Said light-receiving equipment Substrate layer structure, It is the semiconductor device which comes to have the light-receiving layer structure containing a euphotic zone established on said substrate layer structure, and two or more semi-conductor layers with which said substrate layer structure is equipped are in the point constituted by having two or more buffer layers which improve the crystallized state of said substrate layer structure.

[0019] In addition to like and the description configuration of the above sixth, the point of the column of a claim according to claim 7 that said euphotic zone is the semi-conductor of a direct gap form has the seventh description configuration of the flame sensor concerning this invention for solving the above-mentioned technical problem.

[0020] In addition to like, the above sixth, or the seventh description configuration, the point of the column of a claim according to claim 8 that the bandgap energy of said euphotic zone is 3.6eV or more has the eighth description configuration of the flame sensor concerning this invention for solving the above-mentioned technical problem.

[0021] The point of the column of a claim according to claim 9 that like, the description configuration of the above eighth, in addition the bandgap energy of said euphotic zone are 4.0eV or less has the ninth description configuration of the flame sensor concerning this invention for solving the above-mentioned technical problem.

[0022] In addition to like and the description configuration of the above eighth, the point of the column of a claim according to claim 10 that the bandgap energy of said euphotic zone is 4.1eV or more has the tenth description configuration of the flame sensor concerning this invention for solving the above-mentioned technical problem.

[0023] In addition to like and the description configuration of the above tenth, the point of the column of a claim according to claim 11 that the bandgap energy of said euphotic zone is 4.4eV or more has the eleventh description configuration of the flame sensor concerning this invention for solving the above-mentioned technical problem.

[0024] The point of the column of a claim according to claim 12 that said euphotic zone contains $Al_xGa_{1-x}N$ ($0<=x<=1$) from like and the above sixth in addition to the eleventh description configuration has the twelfth description configuration of the flame sensor concerning this invention for solving the above-mentioned technical problem.

[0025] The point of the column of a claim according to claim 13 that the like and acid-resisting means which reduces the reflection factor of the incident light in said euphotic zone in said light-receiving layer structure in addition to the above sixth to twelfth description configuration is formed in the incident light side on said euphotic zone has the thirteenth description configuration of the flame sensor concerning this invention for solving the above-mentioned technical problem.

[0026] In addition to like and the description configuration of the above thirteenth, the 14th description configuration of the flame sensor concerning this invention for solving the above-mentioned technical problem has said acid-resisting means in the point of the column of a claim according to claim 14 which

is a light transmission layer with a refractive index smaller than said euphotic zone.
[0027] Effectiveness is explained below at an operation list. In the synthetic light transmittance spectrum [according to the first description configuration of the flame sensor concerning this invention] by two or more filter means Since the 1st permeability in the wavelength region for detection is larger than the 2nd permeability in the protection-from-light wavelength region which is in a long wavelength side rather than the wavelength region for detection, the wavelength of the light by which passes a filter means and incidence is carried out to the light-receiving equipment of a flame sensor is chosen restrictively. It can avoid including light other than the wavelength region for detection. Since it is ensured that it is only that to which the light received by the light-receiving equipment of a flame sensor makes a flame the origin, the possibility of incorrect detection of a flame sensor can be eliminated. Moreover, in two or more filter means formed in a flame sensor, since the property of the light transmittance spectrum which each filter means has can be set up variously, the setting degree of freedom of the synthetic light transmittance spectrum obtained as a result can make it high.
[0028] Furthermore, since the value of the 1st sensibility in the 1st predetermined wave in the wavelength region for detection is in a protection-from-light wavelength region and can make it 10,000 or more times of the value of the 2nd sensibility in with a wave [2nd] 50nm long wavelength from the 1st wave, only the light of the flame made applicable to detection is detectable with high wavelength selection nature. Furthermore, it is contained in each semi-conductor layer, and since it can prevent that originate in existence of the defective level which absorbs light other than the wavelength region for detection, and a photocurrent occurs, even if the light of the flame in the wavelength region for detection is feeble, it is detectable good.
[0029] In the synthetic light transmittance spectrum [according to the second description configuration of the flame sensor concerning this invention] by two or more filter means Since the 1st permeability in the wavelength region for detection is larger than the 2nd permeability in the protection-from-light wavelength region which is in a long wavelength side rather than the wavelength region for detection, the wavelength of the light by which passes a filter means and incidence is carried out to the light-receiving equipment of a flame sensor is chosen restrictively. It can avoid including light other than the wavelength region for detection. Since it is ensured that it is only that to which the light received by the light-receiving equipment of a flame sensor makes a flame the origin, the possibility of incorrect detection of a flame sensor can be eliminated. Moreover, in two or more filter means formed in a flame sensor, since the property of the light transmittance spectrum which each filter means has can be set up variously, the setting degree of freedom of the synthetic light transmittance spectrum obtained as a result can make it high.
[0030] Furthermore, since the value of the 1st sensibility in the 1st predetermined wave in the wavelength region for detection is in a protection-from-light wavelength region and can make it 10,000 or more times of the value of the 2nd sensibility in with a wave [2nd] 50nm long wavelength from the 1st wave, only the light of the flame made applicable to detection is detectable with high wavelength selection nature. Furthermore, it is contained in each semi-conductor layer, and since it can prevent that originate in existence of the defective level which absorbs light other than the wavelength region for detection, and a photocurrent occurs, even if the light of the flame in the wavelength region for detection is feeble, it is detectable good.
[0031] furthermore, to the light-receiving layer structure (it is hereafter described as the 1st euphotic zone) established corresponding to the above-mentioned 1st composition light transmittance spectrum To the light-receiving layer structure (it is hereafter described as the 2nd euphotic zone) in which incidence of the light of the wavelength region for detection and the light which has leaked in a protection-from-light wavelength region was carried out, and it was prepared corresponding to the above-mentioned 2nd composition light transmittance spectrum Since incidence of the light which has leaked in a protection-from-light wavelength region is carried out, the photocurrent generated by originating only in the light of the flame in the wavelength region for detection by subtracting the photocurrent generated in the 2nd euphotic zone from the photocurrent generated in the 1st euphotic zone can be derived. Furthermore, although the current component resulting from the thermionic

emission generated corresponding to a temperature change is contained in the photocurrent generated in the 1st euphotic zone and the 2nd euphotic zone, as mentioned above, the current component which originates in thermionic emission by taking the difference of a photocurrent is offset, and the effectiveness that temperature compensation can be performed is also demonstrated. Therefore, the judgment precision of turning on and off of a flame is high, and can constitute easily the flame sensor in which a highly precise temperature compensation is possible.
[0032] Even when the light of the flame which is in the wavelength region for detection which receives light from the value of the 1st sensibility of the above being 100,000 or more times of the value of the 2nd sensibility of the above is feeble according to the third description configuration of the flame sensor concerning this invention, the flame sensor which can distinguish still more clearly the photocurrent generated by the light from the photocurrent by the light which is not made applicable to detection, and can detect it can obtain.
[0033] The filter means which can intercept the light of a visible region good from an ultraviolet area according to the fourth description configuration of the flame sensor concerning this invention, Since the filter equipment which had the filter means which can intercept an ultraviolet area good especially put together is used, the light by which incidence is carried out to light-receiving equipment The light of the flame in the wavelength region for detection can be made to penetrate good, intercepting the light and ultraviolet radiation which are contained in indoor light and sunlight from various lighting devices good. Since the light of the sensibility wavelength region (wavelength of 300nm - 400nm) by the defective level which is contained in each semi-conductor layer and absorbs light other than the wavelength region for detection especially can be intercepted good, a flame sensor which a photocurrent generates only to the light of the flame in the wavelength region for detection can be obtained.
[0034] Since both the colored glass filter and the multilayers filter are applied to the light irradiated by the flame sensor according to the fifth description configuration of the flame sensor concerning this invention, the permeability spectrum near [which starts gently (or it falls)] absorption edge wavelength of the light which could be made to penetrate only the light of the specific wavelength range by the colored glass filter, and penetrated the colored glass filter with the multilayers filter can be changed steeply. That is, after penetrating two or more filter means, in other words, the permeability spectrum of the light by which incidence is carried out to light-receiving equipment can constitute the light filter which changes rapidly and which has high wavelength selection nature from specific wavelength.
[0035] According to the sixth description configuration of the flame sensor concerning this invention, the substrate layer structure of light-receiving layer structure can also make good the crystallized state of the light-receiving layer structure deposited on it by coming to have the two or more layers buffer layer which improves the own crystallized state of substrate layer structure. I hear that that the crystallized state of light-receiving layer structure is good has the low defect density which forms defective level into a layer, there is, and it seems not to have sensibility in different wavelength range from the wavelength range of a flame. The sensibility in near the absorption edge wavelength of a euphotic zone changes steeply, that is, specifically, can offer the high flame sensor of the wavelength selection nature that the wavelength range which receives light can be limited.
[0036] According to the seventh description configuration of the flame sensor concerning this invention, a euphotic zone absorbs light by direct transition because a euphotic zone is the semi-conductor of a direct gap form. Since a light absorption process is based on the direct transition in a euphotic zone, the wavelength property of an absorption coefficient changes rapidly in absorption edge wavelength (equivalent to bandgap energy), and the light of the wavelength region absorbed bordering on absorption edge wavelength and the light of the wavelength region which is not absorbed are separated clearly. Consequently, the effectiveness that high wavelength selection nature is demonstrated also in a euphotic zone can be acquired.
[0037] According to the eighth description configuration of the flame sensor concerning this invention, the flame sensor which can detect alternatively the light of the wavelength below the wavelength of about 344nm (3.6eV), i.e., the light of a flame which appears in a wavelength region with a wavelength of about 344nm or less, by the above-mentioned euphotic zone because the bandgap energy of the

above-mentioned euphotic zone is 3.6eV or more can be obtained.
[0038] According to the ninth description configuration of the flame sensor concerning this invention, the bandgap energy of the above-mentioned euphotic zone because it is [3.6eV or more] 4.0eV or less The light of the wavelength of the range of about 310nm (4.0eV) - 344nm (3.6eV) wavelength, That is, the flame sensor which can detect the luminescence peak resulting from luminescence of OH radical observed when burning the compound which contains a hydrocarbon also especially in the light of the flame in the wavelength region for detection good can be obtained. Since a light called the indoor light and the sunlight from various lighting devices which are observed by coincidence does not exist especially when the installations of a flame sensor are closed space, such as the interior of an engine, and installed in the outdoors, only the light of the flame in the wavelength region for detection is detectable good.
[0039] According to the tenth description configuration of the flame sensor concerning this invention, the flame sensor which can detect the light of the wavelength below the wavelength of about 300nm (4.1eV), i.e., the light of the flame in the wavelength region for detection, by the above-mentioned euphotic zone because the bandgap energy of the above-mentioned euphotic zone is 4.1eV or more can be obtained. Furthermore, since the above-mentioned euphotic zone does not have sensibility to the indoor light from the light, i.e., the various lighting devices etc., of the wavelength exceeding the wavelength of about 300nm etc., the flame sensor which has sensibility alternatively to the light of the flame in the wavelength region for detection can be obtained.
[0040] According to the eleventh description configuration of the flame sensor concerning this invention, the flame sensor which can detect the light of the wavelength below the wavelength of about 280nm (4.4eV), i.e., the light of the flame in the wavelength region for detection, by the above-mentioned euphotic zone because the bandgap energy of the above-mentioned euphotic zone is 4.4eV or more can be obtained. Furthermore, since the above-mentioned euphotic zone does not have sensibility to the indoor light and the sunlight (natural light) from the light, i.e., the various lighting devices etc., of the wavelength exceeding the wavelength of about 280nm etc., the flame sensor which has sensibility alternatively to the light of the flame in the wavelength region for detection can be obtained.
[0041] According to the twelfth description configuration of the flame sensor concerning this invention, a euphotic zone can set the bandgap energy of a euphotic zone as arbitration by adjusting the presentation ratio x of aluminum by consisting of an included nitride semi-conductor containing $Al_xGa_{1-x}N$ ($0<=x<=1$). Consequently, although the cut-off wavelength of a euphotic zone is set up and it has sensibility neither in various lighting devices nor sunlight, a flame sensor which has sensibility to the light of the flame in the wavelength region for detection can be offered.
[0042] According to the thirteenth description configuration of the flame sensor concerning this invention, the quantity of light (the amount of energy) by which incidence is carried out to a euphotic zone compared with the case where the acid-resisting means is not established, by the acid-resisting means being formed in the incident light side on a euphotic zone can be increased. Consequently, since it is equivalent to the photoelectric conversion efficiency in a euphotic zone having increased, even if the luminous intensity from a flame is weak, it can detect with sufficient sensibility or a flame sensor can be offered.
[0043] According to the 14th description configuration of the flame sensor concerning this invention, with an acid-resisting means consisting of light transmission layers which have a refractive index smaller than the refractive index of a euphotic zone, the light transmission layer which has a desired refractive index can be produced easily, consequently incidence of the light can be carried out good to a euphotic zone by adjusting chemical composition, thickness, etc. of the light transmission layer.
[0044]
[Embodiment of the Invention] Below, the example of a configuration of a flame sensor is explained with reference to drawing 1 . The flame sensors 20 and 30 shown in drawing 1 (a) and drawing 1 (b) receive the incident light from a flame, are equipped with the ****** equipments 21 and 23 made to generate a photocurrent and the filter equipment 22 which can make the light of the wavelength range of desired penetrate or intercept, and are constituted. The equipment which has responsibility in light-

receiving equipment to the light of the flame in the wavelength region for detection is used, and the following operation gestalten illustrate and explain the light-receiving equipment 21 which consists of semiconductor device structure of an PIN mold, and the light-receiving equipment 23 which consists of semiconductor device structure of a schottky diode mold.

[0045] First, the flame sensor 20 shown in drawing 1 (a) is equipped with the light-receiving equipment 21 (PIN mold) which receives the incident light from a flame, and the filter equipment 22 which can make the light of the wavelength range of desired penetrate or intercept, and is constituted. Light-receiving equipment 21 on the substrate 1 constituted using sapphire The 1st buffer layer 2 (AlN made to deposit at low temperature), The crystal improvement layer 3 (GaN) and the 2nd buffer layer 4 (AlN made to deposit at low temperature) on the substrate layer structure produced by carrying out sequential deposition The n-type-semiconductor layer 5 (n-AlxGa1-xN (x= 0.4)), The i-type semiconductor layer 6 (i-AlxGa1-xN (x= 0.4)) of undoping, The sequential deposition of the p type semiconductor layer 7 (p-GaN) is carried out, and light-receiving layer structure is formed. It is prepared so that an electrode 8 (Ti/aluminum/Au) may serve as ohmic contact at the part on the n-type-semiconductor layer 5, and the electrode 10 (Au) is further prepared and constituted with the electrode 9 (nickel/Au) by the part on the p type semiconductor layer 7 at the part on an electrode 9. Moreover, filter equipment 22 comes to have the 1st filter means 11 and the 2nd filter means 12. Moreover, the silicon (Si) other than sapphire can also be used as an ingredient of a substrate 1.

[0046] Next, the flame sensor 30 shown in drawing 1 (b) is equipped with the light-receiving equipment 23 (schottky diode mold) which receives the incident light from a flame, and the filter equipment 22 which can make the light of the wavelength range of desired penetrate or intercept, and is constituted. Light-receiving equipment 23 on the substrate 1 constituted using sapphire The 1st buffer layer 2 (AlN made to deposit at low temperature), The crystal improvement layer 3 (GaN) and the 2nd buffer layer 4 (AlN made to deposit at low temperature) on the substrate layer structure produced by carrying out sequential deposition The n-type-semiconductor layer 5 (n-AlxGa1-xN (x= 0.4)), The sequential deposition of the i-type semiconductor layer 6 (i-AlxGa1-xN (x= 0.4)) of undoping is carried out, and light-receiving layer structure is formed. It is prepared so that an electrode 8 (Ti/aluminum/Au) may serve as ohmic contact at the part on the n-type-semiconductor layer 5. It is prepared so that an electrode 9 (nickel/Au) may serve as Schottky contact to the i-type semiconductor layer 6 on the i-type semiconductor layer 6, and the electrode 10 (Au) is further prepared and constituted by the part on an electrode 9. Moreover, filter equipment 22 comes to have the 1st filter means 11 and the 2nd filter means 12 like drawing 1 (a). Moreover, the silicon (Si) other than sapphire can also be used as an ingredient of a substrate 1.

[0047] Here, the i-type semiconductor layer 6 absorbs light by direct transition by the i-type semiconductor layer 6 used as a euphotic zone being produced with the III-V group nitride semi-conductor of a direct gap form. Therefore, by the above-mentioned flame sensor, since a light absorption process is based on the direct transition in the i-type semiconductor layer 6, the wavelength property of an absorption coefficient changes rapidly in absorption edge wavelength (equivalent to the bandgap energy of the i-type semiconductor layer 6), and the light of the wavelength region absorbed bordering on absorption edge wavelength and the light of the wavelength region which is not absorbed are separated clearly. Consequently, the effectiveness that the high wavelength selection engine performance is demonstrated by the i-type semiconductor layer 6 can be acquired.

[0048] Furthermore, in order to give wavelength selection nature to a flame sensor, adjusting the presentation ratio of aluminum in the i-type semiconductor layer 6 (AlxGa1-xN) which is a euphotic zone, and setting the bandgap energy as a desired value is performed. For example, what is necessary is just to carry out to the aluminum presentation ratio x= 0.05 or more than it to produce the flame sensor which can receive alternatively the light of the flame in the wavelength region for detection which spreads in a wavelength region with a wavelength of about 344nm or less so that the bandgap energy of the i-type semiconductor layer 6 may be set to 3.6eV or more. Or what is necessary is just to carry out to the aluminum presentation ratio x= 0.25 or more than it to produce a flame sensor which is contained in wavelength region about 300nm or more and which receives the light of the flame in the wavelength

region for detection, without receiving the light (indoor light) from various lighting devices so that the bandgap energy of the i-type semiconductor layer 6 may be set to 4.1eV or more. moreover -- or the bandgap energy of the i-type semiconductor layer 6 is set to 4.4eV or more to produce a flame sensor which is contained in wavelength region about 280nm or more and which receives only the light of the flame in the wavelength region for detection, without receiving the light from sunlight -- as -- the aluminum presentation ratio x= 0.37 or more than it -- then, it is good.

[0049] Furthermore, since the indoor light or the sunlight which were mentioned above do not exist when a flame sensor is installed in closing space, such as the interior of an engine, it is not necessary to set up large bandgap energy which eliminates them. The sake, Also especially in the light of the flame in the wavelength region for detection, a hydrocarbon The light (light of a with a 310nm or more wavelength [344nm or less] flame) of the luminescence peak (: with a wavelength of about 310nm (310nm**10nm) 4.0eV) resulting from luminescence of OH radical observed when burning the included compound (fuel which burns with an engine) by that of receiving light alternatively What is necessary is just to make the aluminum presentation ratio x or less [0.05 or more] into 0.23 so that the bandgap energy of the i-type semiconductor layer 6 may be set to 3.6eV or more 4.0eV or less when the flame sensor to cut is produced.

[0050] Here, when growing up the above-mentioned i-type semiconductor layer 6 (III-V group nitride semi-conductor), the number of the nitrogen (N) holes in a nitride semi-conductor layer can be decreased by adjusting so that the ratio (V/III) of the amount of supply of V group element to the amount of supply of an III group element may become 5000 or more. Since a nitrogen hole can serve as a hopping site which contributes to hopping conduction, it can adjust the carrier concentration in the obtained i-type semiconductor layer 6 even to low level called three or less [about 1x1015cm -] because the number of nitrogen holes decreases, and can obtain the semiconductor device which has good quantum efficiency and a good speed of response. Here, if the oxygen which acts as a carrier dopant is fully removed from the membrane formation system, carrier concentration can be adjusted even to still lower level called three or less [about 5x1014cm -]. In addition, although carrier concentration can be adjusted even to equivalent level when membranes are formed by making the value of V/III or more into 1000, or also when membranes are formed by making the value of V/III or more into 500 When the number of nitrogen (N) holes is not fully able to be decreased by forming membranes by making the value of V/III small, a problem may occur in the use as a flame sensor by which it is required that a feeble light should be detected. For example, the photocurrent which should be detected may not appear clearly from that the dark current increases by existence of the above-mentioned hopping site, the trap of the optical carrier generated by absorbing the light of the flame in the wavelength region for detection being carried out in impurity level, etc.

[0051] Drawing 2 is a graph which shows each spectrum of the light of the flame by which incidence is carried out to the flame sensors 20 and 30, sunlight, and indoor light. It is here, and in indoor light, in the wavelength range of a visible region, breadth and sunlight spread in the wavelength range of a visible region from an ultraviolet area with a wavelength of about 290nm or more, and the light of breadth and a flame has spread from the ultraviolet area with a wavelength of about 320nm or more in the wavelength range of about 200nm - about 340nm. Therefore, it is necessary to intercept alternatively the light of the wavelength range which spreads in a visible region from the ultraviolet area of indoor light which was illustrated, and sunlight, and to use for the light-receiving equipments 21 and 23 of the flame sensors 20 and 30 the filter equipment 22 which ensures that incidence only of the light of the flame in the wavelength region for detection is carried out. Furthermore, since defective level which generates a photocurrent to the light of the wavelength range of 300nm - 400nm wavelength is contain in the semi-conductor layer which constitutes a flame sensor as mention above, the light of the above-mentioned wavelength range is not irradiate by light-receiving equipment by intercept the light of the wavelength range further, but it is necessary to use the filter equipment 22 it is make not to make make it almost generate a photocurrent. Therefore, it is desirable that filter equipment 22 is equipped with at least two filter means 11 and 12 of a 1st filter means 11 to have the property that the average transmission coefficient in the wavelength range of 400nm - 700nm wavelength is 10% or less at least,

and a filter means 12 by which it has the property that the average transmission coefficient in the wavelength range of 300nm - 400nm wavelength is 30% or less at least.
[0052] With reference to the following drawing 3 - drawing 6 , the example of the 1st filter means 11 with which filter equipment 22 is equipped, and the 2nd filter means 12 is explained using the graph of each permeability property.
[0053] What is shown in drawing 3 is the permeability property of the light filter (colored glass filter) currently sold from Hoya Corp., and shows as an example U-330, U-340, U-350, and the permeability property of the light filter U-360 [light filter] is written. Here, the figure appended to each light filter expresses the wavelength from which permeability becomes the highest. By making light penetrate using the light filter which has wavelength selection nature which is illustrated, the optical reinforcement of the light of the specific wavelength range is reduced suitably. For example, if its attention is paid to the permeability property of U-330, the transparency threshold wavelength by the side of the short wavelength of a transparency peak is located in about 210nm, and since the transparency threshold wavelength by the side of merit is located in about 425nm, the optical reinforcement of light other than the with a - of with a wavelength of 210nm long wave range will be reduced. Furthermore, in the wavelength of 280nm, permeability is over 30%, permeability is over 70% in the range of the wavelength of 270nm - 370nm wavelength, and since permeability is over 80% in the range of the wavelength of 280nm - 300nm wavelength, the light of the wavelength range of the light of a flame (200nm - 340nm) can penetrate a light filter, without almost reducing the reinforcement.
[0054] however, from the standup of a permeability spectrum being loose and the skirt of a permeability spectrum dragging on So that the sunlight or indoor light near the wavelength of 400nm cannot be completely intercepted when U-330 is used, but only the light of the flame which has a euphotic zone in the wavelength region for detection may be received In a euphotic zone, even if it adjusts the bandgap energy, when defective level which receives the light of the range of 300nm - 400nm wavelength exists, sunlight and indoor light will be absorbed and a photocurrent will be generated.
[0055] What is necessary is just to perform making the impurity contained increase or increasing thickness, in order to lower the permeability of light using a colored glass filter. However, by this approach, since glass with low permeability is used, the permeability of only the light of the specific wavelength range cannot be lowered, but decline in permeability is caused in the overall wavelength range. Therefore, when making applicable to detection luminescence which exists in an ultraviolet area among luminescence of a flame, the ratio of the permeability in the wavelength for detection and the permeability in the protection-from-light wavelength region which is in a long wavelength side rather than the wavelength region for detection is about double figures.
[0056] What is shown in drawing 4 is the permeability property of another light filter (colored glass filter) currently sold from Hoya Corp., and shows as an example UV-28, UV-30, UV-32, UV-34, and the permeability property of the light filter UV-36 [light filter] are written. Here, the figure appended to each light filter is equivalent to 1/10 of the figures of transparency threshold wavelength, and if it is UV-28, it shows that transparency threshold wavelength is 280nm. Here, UV-28 are produced using phosphate glass etc. and UV-30, UV-32, UV-34, and UV-36 are produced using silicate glass etc. Unlike the filter shown in drawing 3 , this colored glass filter intercepts the light by the side of short wavelength rather than permeability threshold wavelength, and has the simple property of making the light by the side of long wavelength penetrating.
[0057] being shown in drawing 5 and drawing 6 -- Asahi -- a spectrum -- it is the permeability property of the light filter (multilayers filter) currently sold from incorporated company, and the permeability property of the light filter it writes UV300 (drawing 5) and UV325 [light filter] (drawing 6) is shown as an example. A multilayers filter is a filter constituted as high wavelength selection nature was shown by making incident light produce interference by carrying out the laminating of the glass of two or more sheets, and negating the light of the specific wavelength range by the interference. The interference fringe which shows that interference of light is used for the graph of a permeability property has appeared, and permeability can be made very small in the specific wavelength range as effectiveness of the interference.

[0058] It turns out that a permeability spectrum changes very steeply and high wavelength selection nature is shown so that clearly out of drawing 5 and drawing 6 . For example, in UV300, the permeability of the wavelength range of 325nm - 370nm wavelength is about 0, in UV325, the permeability of the wavelength range of 340nm - 390nm wavelength is about 0, and the standup is very steeper still. What is necessary is just to adjust the thickness of the glass which carries out a laminating, in order to adjust the wavelength range of the light negated by interference.
[0059] A multilayers filter is constituted in piles two or more sheets in an ingredient with high permeability also in ultraviolet areas, such as magnesium flux, SiO2, and an alumina. The principle is constituting the ingredient of predetermined thickness in piles, interference of light arises among them and the light of specific wavelength is negated. Therefore, what is necessary is just to negate light repeatedly by producing interference for many ingredients repeatedly in piles, in order to lower the permeability of the light of the specific wavelength range. In this case, since the ingredient with the above high permeability is used, the permeability of the light of the wavelength range which interference does not produce is maintained while it has been high, consequently it can be set up until the ratio of the permeability in the wavelength for detection and the permeability in the protection-from-light wavelength region which is in a long wavelength side rather than the wavelength region for detection becomes about 5 figures.
[0060] From the above thing, U-330 which is a colored glass filter is used for the 1st filter means 11. When UV300 which is a multilayers filter is used for the 2nd filter means 12, In the 1st filter means 11, the light of the wavelength range of the wavelength of about 400nm or less of the incident light and wavelength about 700nm or more is intercepted. With the 2nd filter means 12 From the ability to shade nearly completely, the light of the wavelength range of the wavelength of 320nm - 380nm wavelength It uses combining the 1st filter means 11 and the 2nd filter means 12, and the effectiveness that light with a wavelength of 300nm or less is effectively shaded by setting the bandgap energy of a euphotic zone (i-type semiconductor layer 6) as predetermined cut-off wavelength is demonstrated. The example of the effectiveness is explained with reference to the following drawing 7 and drawing 8 .
[0061] When (A) filter means is not formed in the light-receiving side of the photodiode used as instead of [of a flame sensor] and only the (B) 1st filter means 11 (U-330) is formed in drawing 7 , the wavelength sensibility (A/W) at the time of forming the 1st filter means 11 (U-330) of (C) and the 2nd filter means 12 (UV300) in a list is shown. Although the ratio of sensibility is seen bordering on the cut-off wavelength (wavelength corresponding to bandgap energy) by (A) having adjusted the bandgap energy of the semi-conductor layer of a direct gap form used as a euphotic zone when the filter means is not established Only 50nm is triple figure (1/1000) extent between the 2nd sensibility in the wavelength by the side of long wavelength from the 1st sensibility [in / in the sensibility ratio / the above-mentioned cut-off wavelength], and the above-mentioned cut-off wavelength. Sensibility to the light of the flame which is in the wavelength region for detection by shading alternatively light other than the wavelength region for (B) detection when only the 1st filter means 11 is established as usual (in a detail) It can respond to the sensibility in cut-off wavelength, and light other than the wavelength region for detection, and a ratio with the sensibility in the wavelength by the side of long wavelength can be raised from the above-mentioned cut-off wavelength only by 50nm even to triple [about] figures (1/1000) - 4 figures (1/10,000). In fact however, the optical reinforcement (for example, optical reinforcement of the sun before and behind the wavelength of 400nm) of the wavelength range corresponding to light other than the wavelength region for detection Since it will become very large compared with the optical reinforcement of the light of the flame in the wavelength region for detection, it was difficult to distinguish and detect the photocurrent in which the photocurrent generated by receiving light other than the wavelength region for detection was also generated by becoming large and receiving the light of a feeble flame.
[0062] When the 1st filter means 11 and the 2nd filter means 12 are established, next, (C), The value of the sensibility in the light (before or after the wavelength of about 270nm corresponding to the cut-off wavelength of a euphotic zone) of the flame in the wavelength region for detection About 4 or more (10,000 or more times) figures of the value of the sensibility in the wavelength (cut-off wavelength of a

euphotic zone only 50nm a long wave before or after the wavelength of about 320nm by the side of merit) corresponding to light other than the wavelength region for detection can be raised. Furthermore, the value of the sensibility in the light (before or after the wavelength of about 270nm) of the flame in the wavelength region for detection can be preferably raised to about 5 or more (100,000 or more times) figures of the value of the sensibility in the wavelength range (wavelength order of about 320nm or, wavelength range beyond it) corresponding to light other than the wavelength region for detection. Consequently, the photocurrent generated by receiving light other than the wavelength region for detection could be made very small, and it became possible to distinguish and detect the photocurrent generated by receiving the light of a feeble flame.

[0063] Furthermore, drawing 8 is the graph which showed the case where the photocurrent value with which it integrated in all the wavelength range in [which was shown in drawing 7] three (A-C) was not being irradiated with the case where the light of a flame is irradiated. Here, although the light of a flame was made to turn on only a fixed period under existence of indoor light and the photodiode was irradiated, when the light of a flame is irradiated, it turns out that a photocurrent is generated and the light of a flame can be detected irrespective of the existence of a filter means. When only indoor light is irradiated by the flame sensor on the other hand when the light of a flame is not being irradiated namely, since it has sensibility to indoor light, the photocurrent is generated in the case (A: a broken line shows) where it does not have the filter means. Similarly, in the case (B: an one-point broken line shows) where it has only the 1st filter means 11, though it is weak, it turns out that it has sensibility to indoor light. Therefore, in above-mentioned A and B, it can be said that the wavelength selection nature as a flame sensor is inadequate.

[0064] Although it was specifically going to receive alternatively only the light of the flame which is in the wavelength region for detection using a filter means with the light-receiving equipment (here, the photodiode was used for convenience) of the conventional type shown in (B) of drawing 7 and drawing 8 so that it might understand out of drawing It was not able to be said that sensibility was producing very low light-receiving equipment to the light (here indoor light) of the wavelength range of wavelength 320nm or more.

[0065] On the other hand, in the case (C: a continuous line shows) where it has the 1st filter means (U-330) 11 and the 2nd filter means (UV300) 12, the photocurrent by which the period which is not making the flame turn on is observed is zero, and it turns out that indoor light can be intercepted good. Therefore, it turns out that a very highly precise flame sensor can be constituted from the ability of the photocurrent generated with the defective level contained in each semi-conductor layer which constitutes a flame sensor to be made very small.

[0066] With the operation gestalt beyond <another operation gestalt <1>>, although only one light-receiving layer structure was prepared in one flame sensor, the following another operation gestalten explain the case where two or more (here two) same light-receiving layer structures are prepared in one flame sensor.

[0067] The flame sensor 40 shown in drawing 9 is equipped with the light-receiving equipment 24 which receives the incident light from a flame, and the filter equipment 25 which can make the light of the wavelength range of desired penetrate or intercept, and is constituted. Although the following operation gestalten illustrate and explain the light-receiving equipment 25 which consists of semiconductor device structure of a schottky diode mold, semiconductor device structures, such as a semiconductor device of other PIN molds, may be used.

[0068] Although the 1st filter means 11 and the 2nd filter means 12 were superimposed and arranged to the serial to incident light as filter equipment with the above-mentioned operation gestalt at the incident light side of light-receiving equipment In addition to the 1st filter means 11 and the 2nd filter means 12, to incident light, the 3rd filter means was partially superimposed on the serial, and is arranged with the following another operation gestalten to the incident light side of light-receiving equipment. Consequently, the area as for which the light which passed only the 1st filter means 11 and the 2nd filter means 12 carries out incidence to light-receiving equipment 24, and the area the light in which the 3rd filter means 13 was passed in addition to the 1st filter means 11 and the 2nd filter means 12 carries out

[an area] incidence to light-receiving equipment 24 are formed.
[0069] As shown in drawing 9 , light-receiving equipment 24 on the substrate 1 constituted using sapphire The 1st buffer layer 2 (AlN made to deposit at low temperature), The crystal improvement layer 3 (GaN) and the 2nd buffer layer 4 (AlN made to deposit at low temperature) on the substrate layer structure produced by carrying out sequential deposition The n-type-semiconductor layer 5 (n-AlxGa1-xN (x= 0.4)), The sequential deposition of the i-type semiconductor layers 6A and 6B (i-AlxGa1-xN (x= 0.4)) of undoping is carried out, and light-receiving layer structure is formed. It is prepared so that an electrode 8 (Ti/aluminum/Au) may serve as ohmic contact at the part on the n-type-semiconductor layer 5. To the part on i-type semiconductor layer 6A and 6B Electrodes 9A and 9B (nickel/Au), Furthermore, Electrodes 10A and 10B (Au) are prepared and constituted by the part on electrode 9A and 9B.
[0070] By establishing two or more light-receiving layer structures, and passing only the 1st filter means 11 and the 2nd filter means 12 so that it may illustrate When the light by which the synthetic permeability spectrum was set to Y passes the 3rd filter means 13 in addition to the light-receiving layer structure (B is added to a reference number) which carries out incidence, and the 1st filter means 11 and the 2nd filter means 12 There is light-receiving layer structure (A is added to a reference number) the light by which the synthetic permeability spectrum was set to X carries out [layer structure] incidence. Moreover, the silicon (Si) other than sapphire can also be used as an ingredient of a substrate 1.
[0071] U-330 shown in drawing 3 as the 1st filter means 11 was used like the above-mentioned operation gestalt, and UV325 shown in drawing 5 as the 2nd filter means 12 was used. Moreover, UV-28 shown in drawing 4 as the 3rd filter means 13 were used. The synthetic light transmittance spectrum X is formed by applying the 3rd filter means 13 to the light of the synthetic light transmittance spectrum Y. Since the 3rd filter means 13 (UV-28) can intercept light with a wavelength [containing the light of a flame / of 280nm] - a wavelength of 290nm or less, it can be said to be that light other than the wavelength region for detection is contained in the synthetic light transmittance spectrum X, and the light of the flame in the wavelength region for detection and light other than the wavelength region for detection are contained in a synthetic light transmittance spectrum.
[0072] As mentioned above, incidence of the light of the flame in the wavelength region for detection and the light other than the wavelength region for detection is carried out to the light-receiving layer structure established corresponding to the above-mentioned synthetic light transmittance spectrum X. By subtracting the photocurrent IB generated in euphotic zone 6B from the photocurrent IA generated in euphotic zone 6A, since incidence of the light other than the wavelength region for detection is carried out to the light-receiving layer structure established corresponding to the synthetic light transmittance spectrum Y The photocurrent I (flame) generated by originating only in the light of the flame in the wavelength region for detection can also be derived. However, since it will be intercepted about 10% by the 3rd filter means 13 (UV-28) not only about light with a wavelength [containing the light of a flame] of 280nm - 290nm or less but about light other than the wavelength region for detection, As the value which amended by applying a predetermined multiplier to Photocurrent IB is shown in following several 1 by subtracting from Photocurrent IA, the photocurrent I by the light of the flame in the wavelength region for detection for which it asks (flame) can be derived. It is f= 1.1 when 10% of light other than the wavelength region for detection is intercepted by the 3rd filter means 13 in following several 1, as the multiplier f was mentioned above.
[0073]
[Equation 1] I(flame) =IA-IBxf [0074] Furthermore, although the current component resulting from the thermionic emission generated corresponding to a temperature change is contained in the photocurrent generated in euphotic zone 6A and euphotic zone 6B, as mentioned above, the current component which originates in thermionic emission by taking the difference of a photocurrent is offset, and the effectiveness that temperature compensation can be performed is also demonstrated. Therefore, the judgment precision of turning on and off of a flame is high, and can constitute easily the flame sensor in which a highly precise temperature compensation is possible.
[0075] <2> Although it performed taking out alternatively the light of the flame which is in the wavelength region for detection using the filter equipment constituted by having two or more filter

means as mentioned above, and carrying out incidence to a light-receiving equipment side With reference to drawing 10 , it explains making light-receiving equipment equipped with the acid-resisting function in which light may be reflected on the front face of the i-type semiconductor layer 6 which is a euphotic zone which constitutes light-receiving equipment, and it is prevented.

[0076] Drawing 10 (a) is the block diagram of light-receiving equipment equipped with the acid-resisting function, drawing 10 (b) is the explanatory view of the acid-resisting functional division shown in drawing 10 (a), and drawing 10 (c) is the explanatory view of the example of a comparison when not having the acid-resisting function.

[0077] First, the flame sensor 50 shown in drawing 10 (a) is equipped with the light-receiving equipment 26 (schottky diode mold) which receives the incident light from a flame, and filter equipment 22, and is constituted. Light-receiving equipment 26 on the substrate 1 constituted using sapphire The 1st buffer layer 2 (AlN made to deposit at low temperature), The crystal improvement layer 3 (GaN) and the 2nd buffer layer 4 (AlN made to deposit at low temperature) on the substrate layer structure produced by carrying out sequential deposition The n-type-semiconductor layer 5 (n-AlxGa1-xN (x= 0.4)), The sequential deposition of the i-type semiconductor layer 6 (i-AlxGa1-xN (x= 0.4)) of undoping is carried out, and light-receiving layer structure is formed. It is prepared so that an electrode 8 (Ti/aluminum/Au) may serve as ohmic contact at the part on the n-type-semiconductor layer 5, similarly, on the i-type semiconductor layer 6, it is prepared so that an electrode 9 (nickel/Au) may serve as ohmic contact, and the electrode 10 (Au) is further prepared and constituted by the part on an electrode 9. And the light transmission layer 14 is formed in the part in which the electrode 10 on an electrode 9 is not formed. Here, the light of the flame in the irradiated wavelength region for detection in which it is formed very thinly penetrates an electrode 9, and incidence of the electrode 9 is carried out to the i-type semiconductor layer 6 which is a euphotic zone good. Moreover, filter equipment 22 comes to have the 1st filter means 11 and the 2nd filter means 12 like drawing 1 (a). Moreover, the silicon (Si) other than sapphire can also be used as an ingredient of a substrate 1.

[0078] The light transmission layer 11 used here is AlxGa1-xN (0<=x<=1), and a refractive index can be adjusted by changing an atomic presentation. Magnesium flux (MgF2), calcium fluoride (CaF2), a silicon dioxide (SiO2), etc. can be used for others. In addition, when AlxGa1-xN is used, there is an advantage that it is producible in the same membrane formation process as each semi-conductor layer.

[0079] Drawing 10 (b) is drawing explaining the acid-resisting functional division with which the semi-conductor structure in the light-receiving equipment 26 shown in drawing 10 (a) was equipped. All over drawing, the refractive index of n1 (n1> n0) and the i-type semiconductor layer 6 is set [the refractive index in air] to n2 (n2> n1) for the refractive index of n0 and the light transmission layer 14. In addition, since the electrode 9 is formed very thinly, it is not taken into consideration here. Furthermore, reflection in case the acid-resisting function is not equipped is explained to drawing 10 (c) as an example of a comparison.

[0080] First, as shown in drawing 10 (a) and drawing 10 (b), a euphotic zone 6 and the light transmission layer 14 are formed, and the reflection factors R1 and R2 to the incident light which carries out incidence at right angles to a euphotic zone 6 about two examples, the case where the above-mentioned light transmission layer 14 is exposed into air, and when the light transmission layer 14 was not formed but the euphotic zone 6 is exposed into air, are shown in following several 1 and several 2. In addition, n0, n1, and n2 are the refractive indexes in air, a light transmission layer, and a euphotic zone, respectively. Here, the thickness d14 of the light transmission layer 14 is set as value:d14=lambda (incident light)/4n1 which broke the quarter wavelength of incident light by the own refractive index. In addition, the wavelength of incident light is the wavelength of light to make it penetrate, for example, is 260nm - 280nm in wavelength.

[0081]

[Equation 2]

R1=(n0 and n2-n1)2/(n0 and n2+n1)2[0082]

[Equation 3] R2=(n0-n2)2/(n0+n2)2[0083] Here, when the presentation ratio y of aluminum and Ga is 1.00, i.e., AlN, in 0.35, each refractive index is set to n0=1.0, n0=2.22, and n0=2.7. [in / in the

presentation ratio x of aluminum and Ga in a euphotic zone / the light transmission layer 14] Furthermore, the thickness of the light transmission layer 14 carries out to the value which did the division of the quarter wavelength of incident light with the refractive index of the light transmission layer 14, i.e., 0.4nm. In addition, the refractive index of a euphotic zone 6 and the light transmission layer 14 is a rough value. The reflection factor R1 at the time of forming the light transmission layer 14 and the reflection factor R2 at the time of not preparing become R1=8.5% and R2=21.1% from the above thing, respectively. Therefore, when the light transmission layer 14 was formed, the light energy which contributes to a photoconduction operation compared with the case where it does not prepare will increase about 16%, and was able to make the photoelectric conversion efficiency of the flame sensor 50 increase about 16% effectually.
[0084] Since the lattice constant of a substrate differs from the lattice constant of a semi-conductor layer when making a semi-conductor layer deposit on <3> substrates, turbulence and a lattice defect may occur [the crystallized state of a semi-conductor layer]. In order to also worsen the crystallized state of the semi-conductor layer deposited further up, even if other semi-conductor layers are prepared between the substrate and the euphotic zone, turbulence will arise in the crystallized state of a euphotic zone, and the turbulence of this crystallized state will form the level which contributes to the light absorption of the wavelength region which is not desirable into a euphotic zone. In view of such a trouble, light-receiving layer structure was formed on the substrate layer structure containing a double buffer with the above-mentioned operation gestalt.
[0085] In the above operation gestalt, although the substrate layer structure of light-receiving equipment contains two or more buffer layers prepared in order to improve the crystallized state, the effectiveness is explained with reference to drawing 11 . Although the graph which shows the wavelength dependency of the light-receiving sensibility of the semiconductor device by which light-receiving layer structure was formed on substrate layer structure is shown in drawing 11 , when the continuous line shown by (a) in drawing is equipped with two or more buffer layers which were explained in the above-mentioned operation gestalt (double buffer), the broken line of (b) and (c) is as a result of [at the time of having one buffer layer as an example of a comparison (single buffer)] measurement. It is a result when the measurement result of (a) forms the light-receiving layer structure of an PIN mold (an electrode/p-GaN/i-AlGaN/n-AlGaN) on the substrate layer structure of a double buffer at a detail. The measurement result of (b) is a result at the time of forming the light-receiving layer structure of a shot key mold (an electrode/n-AlGaN) on the substrate layer structure of a single buffer. The measurement result of (c) is a result at the time of forming the light-receiving layer structure of a shot key mold (an electrode/n-AlGaN) on the substrate layer structure of a single buffer.
[0086] Although the light-receiving sensibility of (a) shows a steep change near absorption edge wavelength when substrate layer structure is equipped with two or more buffer layers and constituted, it can be said that this is the effectiveness (defective level was made not to be contained) which the crystallized state of the upper semi-conductor layer was able to become good by preparing two or more buffer layers, consequently was able to make the crystallized state of a euphotic zone good. On the other hand, light-receiving sensibility when substrate layer structure is equipped with one buffer layer and constituted ((b) and (c)) Near absorption edge wavelength shows a loose change. This Since the improvement of the crystallized state in substrate layer structure is inadequate, it can be said that it is the effect by the defective level which becomes inadequate [an improvement of the crystallized state of a euphotic zone], consequently contributes to a euphotic zone at the absorption of light of the wavelength region which is not desirable having occurred.
[0087] As mentioned above, with the above-mentioned operation gestalt, since the euphotic zone was formed above the substrate layer structure equipped with two or more buffer layers, light-receiving sensibility was able to obtain the light-receiving equipment which changes rapidly before and behind absorption edge wavelength. Consequently, the flame (wavelength region which receives light can be limited and light of feeble flame can be detected alternatively) sensor which can enlarge further the sensibility difference in absorption-edge-wavelength order was able to be obtained as mentioned above by applying two or more filter means to light-receiving equipment. When a euphotic zone is formed

above the substrate layer structure constituted by having one buffer layer on the other hand, even if it applies a filter means, the sensitivity curve in absorption-edge-wavelength order cannot become loose with as, and the wavelength region which receives light cannot fully be limited, but it becomes difficult to detect only the light of a feeble flame alternatively.
[0088] <4> Although the component of an PIN mold and a schottky diode mold was mentioned as the example and the above-mentioned operation gestalt explained it as light-receiving equipment, the invention in this application is not limited to the structure of light-receiving equipment (semiconductor device), and can be applied to an avalanche photodiode and various light-receiving equipments which used other various semiconductor devices.

[Translation done.]

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] (a) And (b) is the example of the sectional view of a flame sensor.
[Drawing 2] It is the graph which shows the spectrum of the light of a flame, sunlight, and indoor light.
[Drawing 3] It is the graph which shows the permeability property of a colored glass filter.
[Drawing 4] It is the graph which shows the permeability property of a colored glass filter.
[Drawing 5] It is the graph which shows the permeability property of a multilayers filter.
[Drawing 6] It is the graph which shows the permeability property of a multilayers filter.
[Drawing 7] It is the graph which shows the measurement result of the sensitivity profile of the flame sensor when having not prepared with the case where a filter means is established.
[Drawing 8] It is the graph which shows the measurement result of the photocurrent when having not prepared with the case where a filter means is established.
[Drawing 9] It is the example of the sectional view of a flame sensor.
[Drawing 10] (a) is the block diagram of light-receiving equipment equipped with the acid-resisting function, (b) is an explanatory view at the time of having the acid-resisting function shown in (a), and (c) is the explanatory view of the example of a comparison when not having the acid-resisting function.
[Drawing 11] It is the graph which shows the wavelength dependency of the sensibility of light-receiving equipment.
[Description of Notations]
1 Substrate
2 1st Buffer Layer
3 Crystal Improvement Layer
4 2nd Buffer Layer
5 N-type-Semiconductor Layer
6 I-type Semiconductor Layer (Euphotic Zone)
7 P Type Semiconductor Layer
8 Electrode
9 Electrode
10 Electrode
11 1st Filter Means
12 2nd Filter Means
13 3rd Filter Means
14 Light Transmission Layer
20 Flame Sensor
21 Light-receiving Equipment
22 Filter Equipment
23 Light-receiving Equipment
24 Light-receiving Equipment
25 Filter Equipment

26 Light-receiving Equipment
30 Flame Sensor
40 Flame Sensor
50 Flame Sensor

[Translation done.]

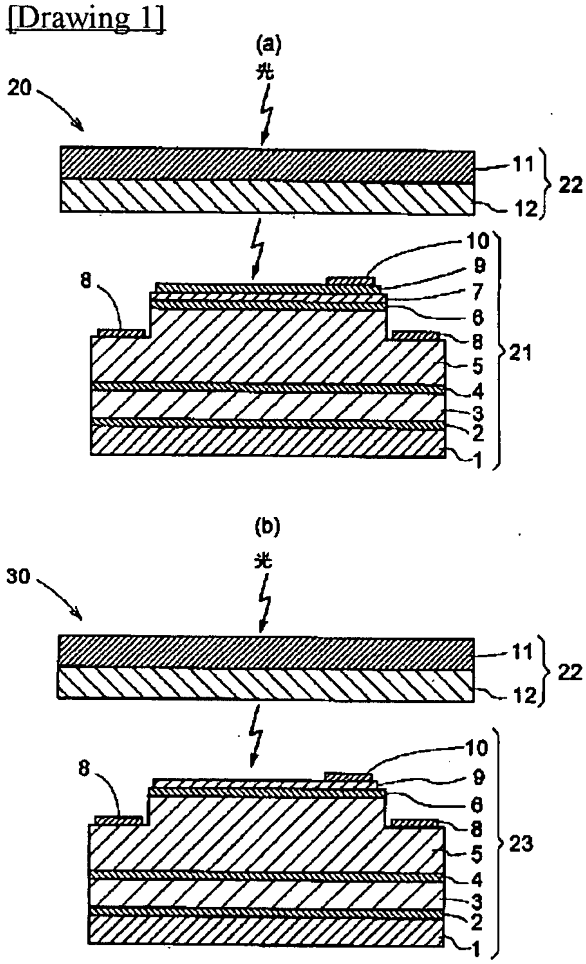
* NOTICES *

JPO and INPIT are not responsible for any damages caused by the use of this translation.

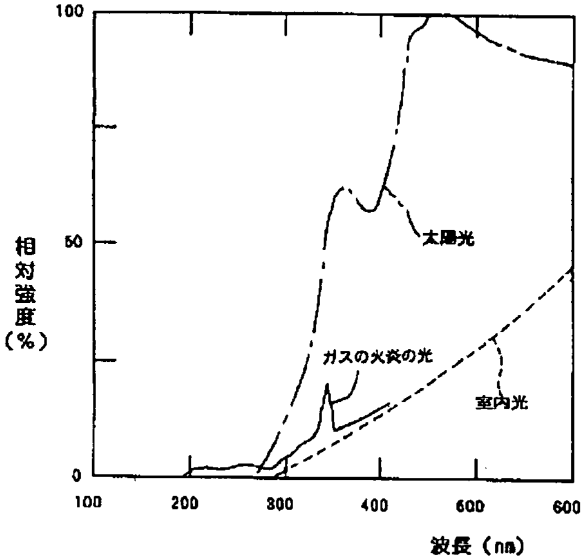
1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

DRAWINGS

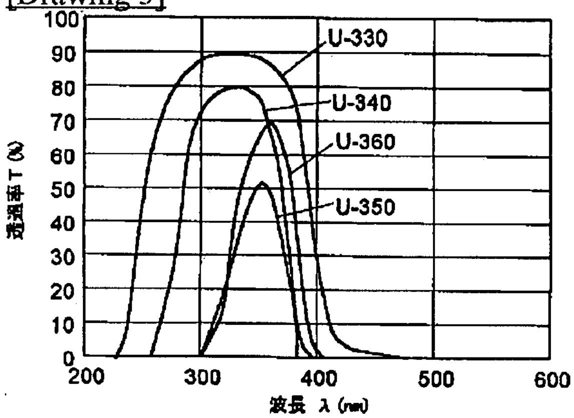
[Drawing 1]



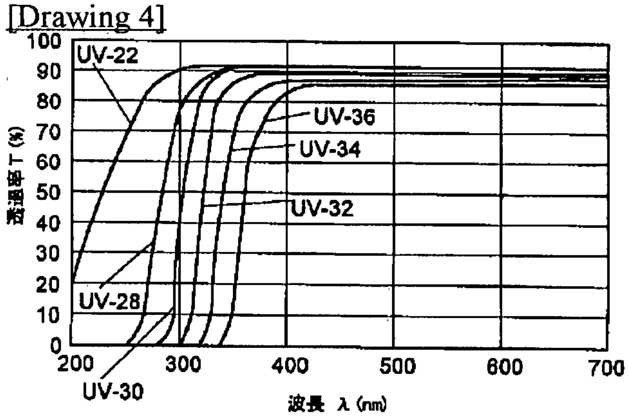
[Drawing 2]



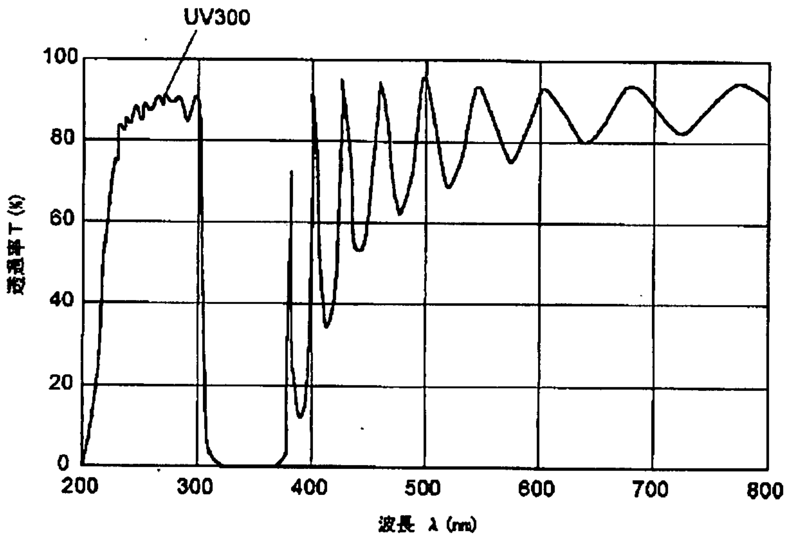
[Drawing 3]



[Drawing 4]



[Drawing 5]



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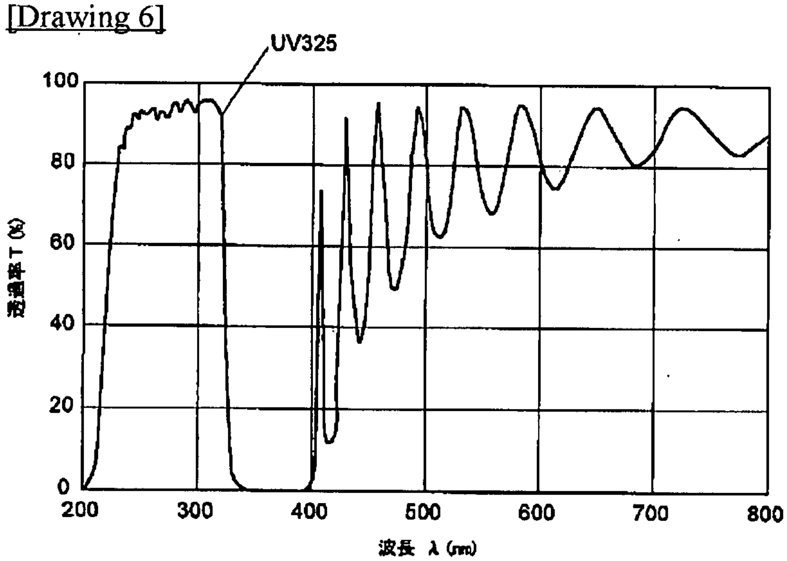
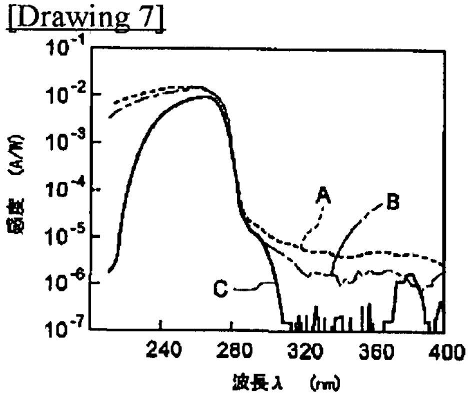
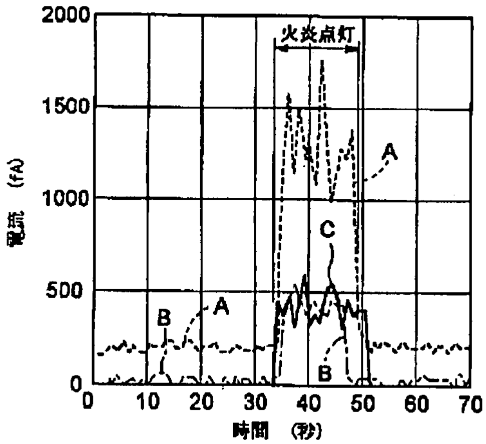


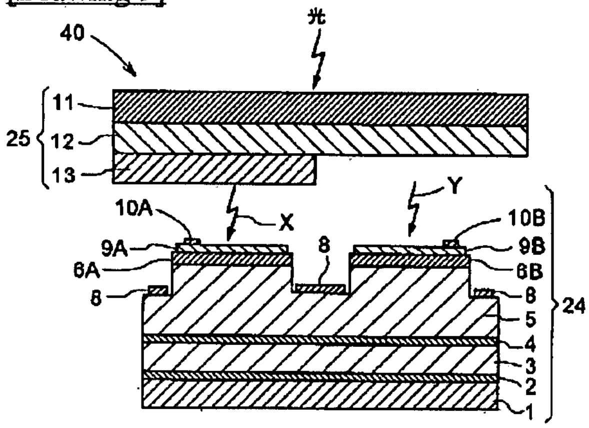
[Drawing 7]



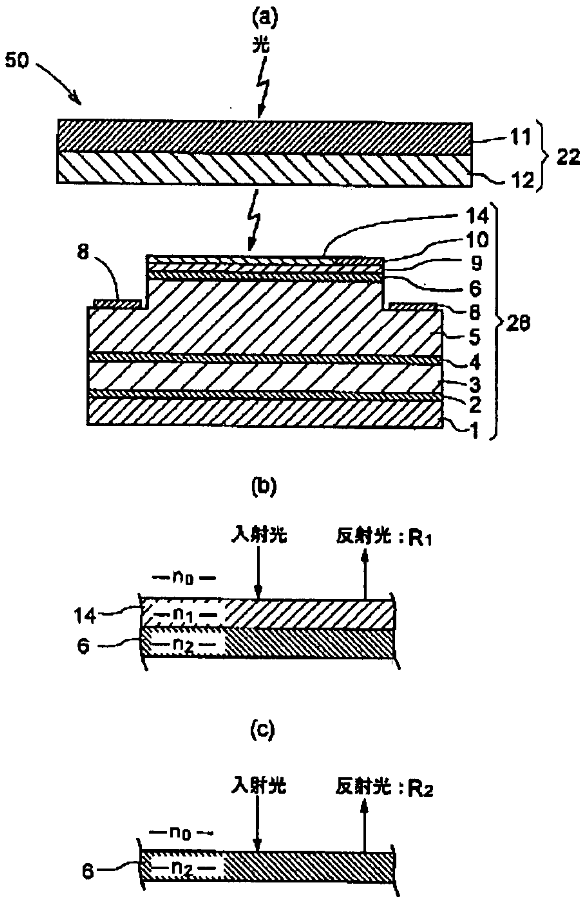
[Drawing 8]



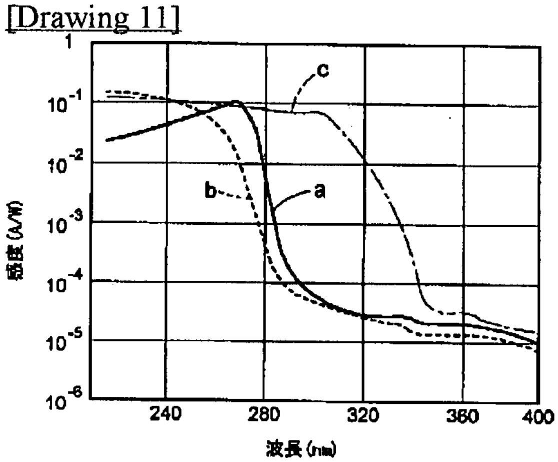
[Drawing 9]



[Drawing 10]



[Drawing 11]



[Translation done.]